LAND ECONOMICS

a quarterly journal of

PLANNING, HOUSING & PUBLIC UTILITIES

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Science and Pragmatics in the Education of Planners

By C. R. VAN HISE

The paper* printed below was originally prepared and delivered by C. R. Van Hise before a meeting of the American Association for the Advancement of Science, in Pittsburgh in 1902. It was called to the attention of the editors of this journal recently by Catherine Bauer and then by Lloyd Rodwin who wrote: "The proper education of planners is a much debated question. Should it be practical or theoretical, with primary emphasis on training in specialized techniques or on development of a broad understanding and a consistent philosophy? The issues are characteristic of new fields of study—especially applied disciplines. This article by Van Hise is so incredibly apt with reference to environmental planning and its base in the social sciences and technical arts, that it ought to be printed where planners could see it. The field is sufficiently peripheral to permit disinterested perusal by planners. The issues are strikingly parallel so as to render translation into planners' lingo unnecessary." And Van Hise's relation to the conservation and resources movement was so significant that republication by this journal appears altogether fitting and proper.—*Ed.*

GEOLOGY is a dynamic science, subject to the laws of energy. Geology treats of a world alive instead of, as commonly supposed, a world finished and dead. The atmosphere, or sphere of air, is ever unquiet; the hydrosphere, or sphere of water, is less active but still very mobile; the lithosphere, or sphere of rock, has everywhere continuous although slow motions. The motions of the atmosphere, the hydrosphere, and the lithosphere alike include body motions by which the positions of large masses of material are changed, and interior motions through which the mineral particles are constantly rearranged with reference one to another, and indeed are constantly remade. Furthermore, the molecules and even the atoms which compose the atmosphere, hydrosphere and lithosphere have motions of marvelous intricacy and speed. These motions are all superimposed upon the astronomical motions—the wobbling revolution of the earth about its axis, the revolution of the earth-moon couple about their common center of gravity, the movement of this couple about the sun at the rate of 68,000 miles per hour, the movement of the solar system among other systems. If it were possible for one to fix in space coordinates by which to

* Reprinted by permission of *Science* magazine in which this article originally appeared (Vol. 16, No. 400, August 29, 1902) under the title, "Training and Work of a Geologist," C. R. Van Hise was president of the University of Wisconsin from 1903 until his death in 1918.

measure these various motions, the movement of an air particle, of a water drop, of a mineral grain would be seen to be extraordinarily complex.

It is clear that there is every reason to believe that no atom or molecule in the world ever occupies the same absolute position in space at any two successive moments. Indeed, it must have been an extraordinary accident, if it ever has occurred, that a single particle has occupied in all the history of the universe exactly the same position that it has occupied at any previous time. No such thing as rest for any particle of matter anywhere in the earth or in the universe is known; but, upon the contrary, every where all particles are moving in various ways with amazing speed.

Geology treats of the world. In order to have more than a superficial knowledge of geology it is necessary to know about the elements which compose the world; how force acts upon these elements; what aggregates are formed by the elements and forces, and how life has modified the construction of the world. Chemistry teaches of matter; how it is made up, both in life and in death. Without an understanding of its principles we cannot have an insight into the constitution of the earth or of any part of it. Physics teaches of the manner in which the many forms of that strange something we call force acts upon matter. Without a knowledge of its principles we can never understand the transformation through which the world has gone. The elements which compose the earth under the laws of physics and chemistry aggregate into those almost lifelike bodies which we call minerals. The minerals are commingled in various ways in the rocks. Without a knowledge of mineralogy one can not have even a superficial understanding of the constitution of rock masses. Biology teaches of the substances alive which clothe the outer part of the earth. Life is one of the most fundamental of the factors controlling the geological transformations in the superficial belt of weathering; it has acted as the greatest precipitating agent in the sea. Life has had therefore a profound and far-reaching effect in determining the nature of the sedimentary formations.

The sciences of chemistry, physics and biology have been built up by using minute parts of the materials of the earth. If geology, or a science of the earth, is to be constructed it must apply to the earth as a whole the principles which have so enlightened us as to the nature and relations of the fractions of the earth which we observe and handle in our laboratories of physics and chemistry and biology.

It thus appears that geology is a composite science; and it might in a certain sense be called an applied science. Indeed I have often defined geology as the application of the principles of astronomy and physics and chemistry and mineralogy and biology to the earth.

Certainly the earth is the single enormous complex aggregate of matter directly within the reach of man. This highly composite earth is the joint result of the work of astronomical, physical, chemical and biological forces, working on an incomparably vaster scale than can ever be imitated in our laboratories. A study of these mighty results has already advanced at many points astronomy, physics, chemistry and biology, and future studies made with direct reference to the causes which have produced the earth are sure to lead to even greater advances in these studies.

If geology is to become a genetic science or, more simply, is to become a science under the laws of energy, geology in large measure must become a quantitative science. In the past it has been too frequently true that, because a single

force or agent working in a certain direction is a real cause of a phenomenon, the conclusion is drawn that it is a sufficient cause. Only occasionally has the question been asked, "Is this cause only a real cause, but is it an adequate cause?" Very often differences of opinion have arisen between geologists, one holding that this cause is the one which explains the phenomenon; another holding that that is the explanation, and each insisting that the other is wrong. In such cases very rarely is the question asked whether the explanations offered are *contradictory* or *complementary*. In many cases the explanation is not to be found in one cause, but in several or many, and thus frequently the conclusions which have been interpreted to be contradictory are really supplementary. To illustrate: but few writers have assigned more than a single cause for crustal shortening. One has held that secular cooling is *the* cause; another has given a different one and has held that secular cooling is of little consequence. But it is certain that secular cooling, vulcanism, change of oblateness of the earth, change of pressure within the earth, changes of form of the material of the earth, and various other causes, are not exclusive of one another, but are all supplementary. The ability to perceive the supplementary nature of various explanations offered for a phenomenon is one of the most marked, perhaps *the* most marked characteristics of the superior man. The new geology must not only ascertain all of the real causes for crustal shortening and other phenomena but in order satisfactorily to solve the problems it must determine the quantitative importance of each.

If I have correctly stated the relations of geology to the other sciences, it follows as a corollary that those only can greatly advance the principles of geology who have a working knowledge of two or more of the sciences upon which it is based.

By working knowledge of a science I mean such a knowledge of its principles as makes them living truths. One must not only be able to comprehend the principles, but he must see them in relation to one another; must be able to apply them. It is not sufficient for a carpenter to be able to explain how the hammer and saw and plane and chisel work; he must be able to use them. He must be able to hit the nail on the head; to cut straight; to plane smooth; to chisel true; and to do all upon the same piece of timber so as to adapt it to a definite purpose in a building. Just so the geologist must be able to apply as tools the various principles of physics and chemistry and biology and mineralogy to the piece of geology upon which he is engaged; and thus shape his piece to its place in the great structure of of geological science.

For instance, to advance geological paleontology one must have a working knowledge of the principles of biology and of stratigraphy. To advance any of the lines of physical geology one must have a working knowledge of the principles of physics, and especially of elementary mechanics. To advance physiography one must have a working knowledge of physics and chemistry. To advance knowledge of the early history of the earth one must have not only a working knowledge of physics and chemistry, but of astronomy. To advance petrology, one must have a working knowledge of physics, chemistry and mineralogy. To advance the theory of ore deposition or metamorphism, one must know not only the principles of physical geology, with all that implies, but he must have a working knowledge of chemistry, physics, mineralogy and petrology. It is unnecessary to add that a geologist must be able to read some of the modern langu-

ages and be able to express himself clearly and logically in one language!

Considering the breadth and thoroughness of the necessary preliminary training for the successful pursuit of geology, one might anticipate that geology would suffer but little from pseudo-scientists. But this anticipation is based upon the idea that no one attempts geological work, and especially to write geological papers, until he is prepared to do so. All sciences have their cranks. Many a town has its philosopher who believes that all of the principles of astronomy, of physics, of chemistry, which have been discovered by the great men of the past are absolutely erroneous, and who makes a new start upon the construction of the world.

It has been plain that a working knowledge of the sciences basal to geology is necessary in order to advance its principles. But I go even further, and hold that such basal knowledge is absolutely necessary in order to do even the best *descriptive* work. Suppose a man to be standing before some complex geological phenomenon. The whole intricate interlocking story is engraved upon the retina of his eye with more than photographic accuracy. The image on the retina is absolutely the same in the eye of this experienced geologist and that of a child, yet if the child be asked to state what he sees, his statements will be of the most general kind and may be largely erroneous. The experienced geologist with a knowledge of the principles of physics and chemistry and biology interprets the phenomena imaged in terms of these subjects. The engraving on his retina is the same as that of the child, but his brain perceives the special parts of the picture of interest to him in their true proportions. He understands what is important, what is unimportant; he must select and record the things which are important. If he attempted to record all that is imaged in his eye, a notebook would be filled with the phenomena to be described at a single exposure; and yet half the story would not be told. Good descriptive work is discriminative. Good descriptive work picks out certain of the facts as of great value; others of subordinate value; and others of no value for the purposes under consideration. How then can this discrimination be made? How can the facts be selected which are of service? Only by an insight into the causes which may have produced the phenomena. Without this insight to some extent at least a description is absolutely valueless. So far as the geologist has such insight, his description has value.

It is frequently urged in opposition to the above that, "if a person has theories in reference to the phenomena which he observes his descriptions will be erroneous; he will be biased by his theories." Unfortunately in many cases this is so; but just so far as it is true, the man fails of the qualities which make a successful geologist. Ones theories undoubtedly control in large measure the selection of the phenomena which are to be noted, and the wisdom of the selection is a certain criterion of the grade of the geologist. But whatever the facts selected for record, the statement of them should be absolutely unbiased by the theories. Invariably, good practice requires that the statement of facts and the explanation of these facts shall be sharply separated. Doubtless each geologist who is listening has at different times had different ideas about the same locality, or while away from a locality a new idea has come as to the meaning of the phenomena there observed. Upon returning to the old locality with the new idea, additional observations of value have been made, but all the statements of facts at the previous visits should be found to be absolutely true. In so far as they are untrue, the

geologist fails of accuracy, the first fundamental observation. If the previous observations are found to be largely erroneous, the man who made them has small chance to become a good geologist. The difference between *bad* observation and *good* observation is that the former is *erroneous*; the latter is *incomplete*. Unfortunately in many cases not only are the observations recorded by many men absolutely false, but they are so intertwined with the theories of the author that one is unable to discriminate between what is intended to be fact and what is advanced as opinion. It is needless to say that the case of such a man is hopeless; that there is no possibility that he shall ever become a geologist. I conclude, therefore, that in order to have a standing in the future, even as a descriptive geologist, one must interpret the phenomena which he observes in the terms of the principles of astronomy, physics, chemistry, mineralogy, and biology.

If my statement thus far be true, the outline of the training of a man hoping to become a professional geologist is clear. Such a man should be sent to thorough and long courses in each of the subjects of astronomy, physics, chemistry, mineralogy and biology. This means that a large part of the training of a geologist is the study of the sciences upon which geology is founded. If a man who hopes to be a geologist is wholly lacking in a knowledge of any of the basal sciences, this defect he can probably never make good. Even if he so desires, the time cannot be found. Moreover, chemistry, physics, mineralogy and biology are laboratory sciences and can be satisfactorily handled only in the laboratory. If the fundamental work in the basic subjects has been done in the college or university, one may keep abreast of their progress during later years; but in order to do this, the basal principles must have become living truths to him while a student. If a personal illustration be allowable, during the past five years, in order to handle the problems of geology before me, I have spent more time in trying to remedy my defective knowledge of physics and chemistry and in comprehending advances in these scenic sciences since I was a college student than I have spent upon current papers in geology; and with, I believe, much more profit to my work. If one has a working knowledge of the basal sciences and lacks training in some branch of geology, its defect he may remedy; for he has the foundation upon which to build. But if he lacks knowledge of the primary principles of the basal sciences he is likely to be a cripple for life, although this is not invariably the case. There are conspicuous instances where lack of early training in the basal sciences has been largely remedied by unusual ability and industry, but this has been most difficult. We should see to it that the young men trained in our colleges and universities, upon whom we place the degree of Doctor in Geology, are not crippled by the necessity of making good in later life defective basal training. Any university which gives a man the degree of Doctor in Geology with a defective knowledge of the basal sciences is wronging the man upon whom the degree is conferred; for this man has a right to expect that his courses shall have been so shaped as to have given him the tools to handle the problems which will arise in his chosen profession.

It is not necessary that all of the basal work shall be done before a man begins his life work, but at least a large part of this work should be done before a man is given the certificate that he can do the work of a professional geologist. But in any case studies in the basal sciences should not cease when the professional degree is granted. Continued studies not

only in the basal subjects but in cognate branches and even those far removed from science should continue through life. The geologist finds that however broad and deep his studies are in basal and cognate subjects, he is continually limited by lack of adequate knowledge of them.

In recent years it has been a mooted question in colleges and universities as to when specialization should begin, rather implying that when specialization begins broadening studies should cease. And, indeed, it is upon this hypothesis that most of the discussion upon this subject has been carried on. Some have held that specialization should not begin until late in the college course, or even rather late in a post-graduate course. Others have held that one should early direct his studies to special subjects which he expects to pursue, and give comparatively little time to other subjects. The argument for this latter course is that competition is now keen; and if a man keeps in the race he must begin to specialize early. It appears to me that both of these answers are inadequate. My answer to the question is that specialization should begin early but the broadening studies should *not* be discontinued. This rule should obtain not only through the undergraduate course, but in the post-graduate work and during professional life. The specialized work will be better done because of the broad grasp given by the other subjects. The broadening studies will be better interpreted because of the deep insight and knowledge of a certain narrow field. Thus each will help the other. No man may hope for the highest success who does not continue special studies and broadening studies to the end of his career.

But is it held that a geologist lacking an adequate working knowledge of basal studies cannot perform useful service? No, the domain of geology is so great, the portion of earth not geologically mapped and the structure worked out is so vast, the ore and other valuable deposits which have received no study are so numerous, that there is an immense field for the application of well-established principles. In geology, as in engineering and other applied sciences, there is an opportunity for many honest, faithful men to perform useful service to the world even if their early training and capacity are not all that could be desired. But even the application of old principles to new areas will be well done in proportion as the geologist has training in the basal sciences; and to the man who combines with such training talent must necessarily be left the advancement of the philosophy of geology. The philosophy of geology, the inner meaning of phenomena, was the paramount consideration to Hutton and Lyell and Darwin. To them facts were useful mainly that they might see common factors, the great principles which underlie them, or, in other words, generalization. To correctly generalize in geology involves the capacity to hold a vast number of facts in the mind at the same time; to see them in their length and breadth and thickness; to see them at the same time as large masses and as composed of parts, even to the constituent mineral particles and the elements; to see the principles of physics and chemistry and mineralogy and biology interlacing through them. Only by holding a multitude of facts and principles in ones mind at the same time can they be reduced to order under general laws.

Failure thus to hold in one's mind a large number of facts and principles leads to lack of consistency. Often in a single book or a single chapter, on the same page, or even in the same paragraph or sentence, are contained ideas which

are exclusive of one another. They are not seen by the writer to be exclusive of one another because he is so lacking in a command of the principles of the basal sciences that he is not aware of the antagonism. Major Powell once said to me, "The stage of the development of the human mind is measured by its capacity to eliminate the incongruous." If this hard criterion were rigidly applied, it would follow that many of our professions have not passed the youthful stage. The man who can insert in the same treatise, chapter, or page incongruous ideas saves an immense amount of cerebral tissue for himself. Such a man can write on through chapters and books, and not find it necessary to go back, adjust and interrelate the various parts. There is no action and reaction between the multitude of ideas. The writer has the easy task of holding in his mind at any one time but a few data. He is in delightful and happy unconsciousness of the fact that many of his statements destroy one another. But the man who sees the phenomena and principles of geology in all their complex relations, and tries to express the parts of them he is considering in proportion to one another, and to place his fragment of the science of geology in proper relations to other departments of geology and other natural sciences, has a task before him requiring great mental effort. He must see and understand in three dimensions. At every point he must see the lines of cause and effect radiate and converge upon the phenomena he is considering from many other phenomena and principles. Of course all fail to do this completely in reference to any complex problem. But in so far as success would be attained, the effort must be made. In proportion as one can hold many facts and principles and sees their interrelations, he will be able to advance the philosophy of geology. This is the work which burns the brain.

And his results he must express in language, the chief means of communicating ideas and relations. Yet language is linear. By figures, models, maps and illustrations, wisely used, one may to an important degree supply the defects of linear language. Yet language and illustration, even where used to the best advantage, but poorly convey one's ideas. Most conscientious writers require as much or more time to put a complex subject into words and illustrations ready for publication as they do in working out the results.

But upon the other side, and in favor of expression in language, it should be remembered that there is action and reaction between one's ideas and the attempt to express them in words and illustrations. The necessity for expression language is often a wonderful clarifier of ideas. The ideas are improved by the attempt at expression, and the expression is continually improved as the ideas are enlarged.

That the difficulty as to expression does not apply to geology alone is well illustrated by the vast amount of labor Charles Darwin spent in putting into the linear form of language the most revolutionary work of the time, *The Origin of Species*. It seemed as if the intricately interrelated facts of life were of so complex a nature that language could not handle the problem. But the genius of Darwin was such that he not only conceived the idea of natural selection and proved its truth in his own mind, but he so marshaled his facts and principles in linear form in one volume that men were forced to believe. Darwin unquestionably saw deeper than he was able to express; and it was the struggle to state what he knew which made the writing of the "*Origin*" such an onerous task. But geology as a whole is only less complex

than life; and many of us in the smaller matters with which we are attempting to deal have felt the impossibility of conveying more than imperfectly the ideas and relations which are in our minds.

In thinking of the marvelous complexity of the phenomena of geology, and seeking for an analogy which might in some measure express this complexity, it seemed to me that the inhabitants of the globe and their intricate relations furnish an approximate illustration. From each individual or family or hamlet or city or metropolis, there go out on foot, by wheel, by wagon, by railway, by vessel, various products, some of them to the remoter parts of the earth. From each center, by letter, telegram, telephone, communications diverge; if the center be a large one, by thousands of lines. To each center, materials and thoughts in a like manner converge. In a similar way one class of geological phenomena is related to nearly all other classes. They are related as to their material parts, as to the forces and agents acting, and as to principle concerned in their production. For instance, an economic geologist will appreciate that the development of an ore deposit depends upon the nature of adjacent rocks, upon earth movements, upon the resultant deformations, upon fractures, upon vulcanism, upon erosion by water and ice and wind, upon the circulation of underground water. One who hopes to gain even an approximately adequate idea of the genesis of an ore deposit and an insight as to what is probably beyond the point where the deposit is "shown up," must be able to handle the intricate principles of geology. In so far as a geological or mining engineer is a master of these, he rises in his profession; in so far as his knowledge of facts and principles is meager, an ore deposit seems a lawless thing which can be dealt with only on the relatively simple principle of the doctrine of chances. If an ore body happens to be found at any place, follow it. If for some unknown reason it is lost or depreciates in value, prod the ground in all directions, up and down, to the right and left in the blind hope that chance may find more ore. In many cases nine tenths of this expensive chance work is done in a manner that a fair knowledge of the occurrences, relations and principles of ore deposits would have shown in advance to be wasted.

It the statement thus far be founded on truth, the training of a geologist is a valuable one from an intellectual point of view. It is the fashion for professors in all departments of learning each to hold that a knowledge of his subject is necessary for a liberal education. I have heard of half a dozen professors, including the classics, history, economics, english, in a single evening each prove to his own satisfaction that a man could not be a good citizen or liberally educated if a knowledge of his special subject were neglected. And at the present time some universities still hold similar views in reference to certain subjects. The claim that this or that subject is essential to a liberal education shows a lack of breadth and lack of capacity to see things in their proper relations. No one language or science is essential to a liberal education. But while this is true, it does not follow that this or that subject may not be essential for a particular career; and in geology capacity to use language for the expression of ideas is absolutely essential. Far be it from my purpose to speak in a derogatory way or to underestimate the value of any line of knowledge. At the present day a man who is trained only in the science or only in the humanities has but one hand; that hand may be strong, but the man can never control the affair before him with the power, with the

nicety, with which does the man with two hands, one of which is the rich treasures of science, and the other the no less rich and important treasures of the humanities, each doing its part in harmony with the corresponding fullness of results. With a fundamental knowledge of both, the scholar of the future may choose as his chief occupation the clear, cold work of science or that of the humanities, which will always have more numerous followers, because of the direct personal interest.

As I have already intimated, I hold that for the best liberal education one must pursue broadening studies from the first to the last, and also that one must early begin to specialize. If this be true, geology may be said to be a very desirable part of a liberal education; for it is built upon the whole realm of pure science; *i.e.*, the knowledge, which applies not only to the earth and all it holds, including man, but to the universe as well. Because of the breadth of training combined with specialization required of a geologist, it might be shown that geology is one of the most useful studies in giving a person a sense of proportion, ideas as to relative values, of perspective, qualities of the first order in this world. It might be held that the intellectual training of the geologist is of a kind which helps him in dealing with men and things; and, therefore, for handling the world's work. But time does not suffice to develop this part of the subject.

I shall now suppose that a geologist is adequately trained, that he has some power in generalization, and considers what should be his method of work. It is assumed that the young geologist spends a part of each year in the field. This field work should include a real mapping with structural and genetic interpretations. The wider a young geologist has traveled, the more numerous the excursions in which he has taken part, the better will be his equipment. But no general work such as this can supply the place of systematic mapping. And the more exact the mapping is, the better the training. Very frequently the educational value of the mapping in detail of a small area is underestimated. Indeed, I hold that nothing else can take its place. Moreover, the only sure way to test a geologist is to require him to delineate upon a map and in structural sections the detailed phenomena of the field. For my part I have more confidence in the future of a young geologist who has mapped in detail twenty-five square miles, and has got out of the area much that is in it, than that of another who has done no detail work but has run over and written about thousands of square miles. Rarely can the general conclusions of a man who has not done systematic mapping be relied upon. In America there have been conspicuous cases of men calling themselves geologists who have never carefully mapped a square mile. Yet some of these by the undiscriminating have been regarded as leading geologists. And in one or two cases these men have gained a wide hearing. But the systems which they built up had little or no relation to the world; and they disappeared with the death of their authors. But a geologist must not only do systematic field work at the outset; he must continue to do such work through the years to a ripened age. Not infrequently a geologist, who in early life has done systematic field work, drops this work and continues writing geological philosophy; but this is a precarious course, which sooner or later makes of him what one of our members calls a "closet geologist." It is only by never-ending action and reaction between the complex phenomena of geology in the field and reflection as to the meaning of

the phenomena that sure results can be obtained.

While one should spend a part of each year in the field, I suspect that many more discoveries of geological principles are made in the office or in the laboratory than in the field. The cow collects the grass in the meadow, and afterwards lies down to chew the cud and digest the food. So the geologist in the field, in the midst of innumerable facts, collects all he can. His notes are a record of his daily collections; and if a successful geologist, of his daily imperfect inferences and deductions. But during the eight or nine months of office and laboratory work he has full opportunity for reflection. He is then likely to see more of the common factors of the facts collected; is more likely to see deeper into the underlying principles which explain them.

This is still more true of the facts collected in the current and during the previous years. Indeed, in the field the observations of the current year are often too prominent on account of their recency, and it is only after some months have elapsed that they take their true proportion in connection with observations of previous years. The use of the material collected not in one year only, but through many years, is *necessarily* done in the office or in the laboratory, and it is only from such large masses of material that broad generalizations can be made.

But the inductions and deductions made in the office and the laboratory during the winter should be tested in the field the following year in the light of the new ideas. The new ideas should not by a fraction modify the correctness of the observations of the previous years; they should be found as accurate as when made. But observations are always incomplete, and with a new idea one invariably adds valuable observations which were not noted before the idea was available.

I once wrote to a number of geologists of this and other countries, asking the directions and dips of the dominant cleavages and joints for the various districts and regions of the world with which they were familiar. From only a single geologist did I obtain data of value. Some geologists wrote that they had not time to observe such subordinate phenomena! These men had evidently not learned the principle that the small but numerous agent or force or structure may have as great or greater importance than more conspicious but less common ones. Darwin should have taught every scientist the principle of the quantitative importance of the small factor when he showed how great is the work of the apparently insignificant earthworm. It seems to me that joints are one of the important phenomena of geology; and this is true whether the point of view be deformation alone, physiography, metamorphism, circulation of groundwater, or the genesis of ores.

While the work of each geologist should be based upon thorough field and office work, and thus have an inductive basis, one should not stop there, but should by deduction ever be looking forward. No one ever held more firmly to fact as a basis for induction than Darwin; but also, no man has more successfully projected by deduction beyond his facts than Darwin. This in biology was a task of extraordinary difficulty. In geology one who has a firm grasp of the principles of physics and chemistry may be more daring. Their principles, if not more definite than the laws of biology, are at least better known and more simple. Therefore, one, after having observed the facts in a district and grasped the principles which explain them, may deduce what are likely to be the facts in the field and

their relations in advance of observation. Or more concretely, after one gets the correct idea as to the meaning of the phenomena for a certain district, he often can tell in advance of observation what he will see; or can find what I call "geology made to order."

There is no better or more severe test of a theory than one's capacity to find geology made to order. If observation of the area where the facts are expected to be found in a certain way shows that nature does not obey the order, this is certain evidence that one or more factors in the problem have been omitted and that the theory is inadequate. In so far as the theory is adequate, the geology will be found as anticipated. The reason for this is the very great complexity and delicate adjustment of the phenomena of nature. To illustrate, if the many parts of some complex machine, such as a Hoe press, or a chronometer, were scattered far and wide, and then one should gather some of these parts, and try to fit them, he might find that a certain set fit perfectly. If this were so, he would know to a certainty that these parts are in the correct positions and relations, even if he did not know the relations of these parts to other parts of the purpose of the whole; for so complex and exact is the adjustment that there is but one way to put the parts together. Another set of parts might be found and these made to fit. But doubtless certain parts would not be found. These would be missing links necessary to make a perfect machine. In this situation, if the man had a genius for mechanical construction, and an insight into principles, he might be able to understand the purpose of the whole, and finally to supply the parts which render the whole a useful machine. This he would be able to do just in proportion as he had mechanical insight.

So the geologist fits together his numerous diverse facts. If he finds a solution of his problem which gives accordance to all the numerous facts observed, he may be sure he is on the right track, even if he is incapable of seeing the full truth, for so delicate is the adjustment of facts that where they are numerous there is usually only one way to put them together. Just in proportion as the man has a working knowledge of the principles of physics and chemistry and biology, and the other cognate sciences, will he be able to eliminate erroneous explanations, combine the facts into groups under true theories, and correctly infer how the different groups are to be adjusted, how the various facts which seem at first to have no definite relations are related. Or, to put it in another way, in proportion as he knows the rules of the game will he be able to correctly interpret the meaning of phenomena and from them to project into the unknown. The importance of understanding the rules of the game is not often appreciated. To the person who is ignorant of the principles of the various sciences all things are possible. So many wonderful things have happened within the past half century that he thinks it possible for anything to happen. He has no principles by which he can determine whether or not a statement is probably true. Hence all sorts of grotesque notions flourish. Indeed, the fact that so many wonderful things have been accomplished makes many more ready to regard as possible any absurdity announced by some so-called "professor."

Probably at no time in the history of the world has the public shown such ready credulity. Indeed, it seems as if the more grotesque and preposterous an idea the more likely it is to receive attention. And this credulity is not confined to those who are altogether ignorant of science. A man may be a very narrow expert in one direction of science and be

wholly ignorant of the rules of the game in reference to another science. For instance, when an eminent biologist says 'bell-ringing, the playing on musical instruments, stone-throwing and various movements of solid bodied, all without human contact or any discoverable physical cause—still occur among us as they have occurred in all ages,'[1] the statements show the author to be so lacking in a comprehension of the principles of physics that he is unable to estimate whether or not a phenomenon of physics is likely or not likely to be true. It is clear that man may be an authority as to biology, and yet be so ignorant of the rules of physics that he may be as simple as a child in reference to that subject. Upon the other hand, a man who has a firm understanding of the principles applicable to a case, or, in other words, he knows the rules of the game, is likely to be able to reach a rather definite conclusion as to whether or not an explanation which suggested itself is in accordance with those rules, and therefore may be true, or it disagrees with some of the well established rules, and therefore is not worth considering.

A geologist once said to me of my teacher and early geological guide, Professor Irving, that he was more correct as to the structure of the Lake Superior region than he ought to have been. But I say that every man is just as correct as to deduction beyond observed facts as he should be. Men with defective basal training and poor intellectual power will always fail when they try to put complex facts together under principles, and especially when they attempt to project by deduction beyond observed facts. But men who have a firm grasp of the principles of the sciences basal to geology, the capacity to correlate these principles and apply them to the facts of geology, will go beyond their observations and by observation. Indeed in this way only can the best geological work be done. After one has projected his deductions in advance of observations, he returns to the field with these new ideas, and then carries his observations farther than he was able to do before. The geologist whose ideas are not continually outrunning his observations will never go far in the science. He whose mind is behind his observations instead of in advance of them will ever be mediocre. The minds of the leaders of geology are on the mountain heights before their feet have more than touched the foothills.

The conclusions deduced by a scientific genius may go so far in advance of observations that he who announces the conclusions may not be able to make observations which confirm the theories during his lifetime. In such cases subsequent observations made through many years by others will find the phenomena confirming the principles. The truths announced by men of insight are often not accepted by slower men until this later observational work is done. Many cases could be cited illustrating these statements. Darwin, in 1860, *knew* that life had existed that would fill in the great gaps in the very imperfect paleontological record. Since 1860 all the greater gaps have been filled by discovered fossils. Mendeleeff, when he saw the law of the periodic arrangement of the elements, *knew* that elements exist which would fill the gaps; but it took many years of work by many men to find a part of them; and during the past few years a a half dozen or more of the vacant places have been occupied. Each geologist, each scientist, now as in the past, is just as right as he should be. The scope of these observations doubtless extends beyond geology. Much of what has been said is true of knowledge as a whole.

[1] Alfred Russell Wallace, *The Wonderful Century*, p. 211.

The Scope and Status of Urban Geography: An Assessment†

By ROBERT E. DICKINSON*

1. The Geographical Approach[1]

IN social surveys and regional town-planning schemes it is invariably assumed that the geographer is primarily concerned with the physical ground-plan on which the city rests. It is sometimes further conceded that the geographer follows such appraisal by tracing the effects of this physical ground-plan on the growth and character of the city, but as a rule the investigation of these particular aspects is handled by the economist, sociologist, historian, or architect. There are, however, numerous thorough studies of cities by geographers, which indicate clearly that urban geography has a well established scope and special techniques. It seems necessary, therefore, to assess the contribution of geography to the study of the city as revealed in such studies in order to indicate to the geographer the status of the subject and to suggest lines of future investigation. Such a review will also demonstrate to the student of urban problems that the trained geographer, from the new graduate upwards, has an equipment and technique that can be applied to the examination of particular problems of social and physical planning.

Economist, historian, sociologist, and geographer study the urban settlement from different angles, and it will be well at the outset to define the geographer's conception of such a settlement since this conditions his particular approach. The urban settlement is regarded by the geographer as a man-made habitat on the earth's surface. The problem of exact definition lies in the smallest urban settlements in any area. With such cases in mind as a basis for discussion, it will be found that size and administrative status are not essential criteria of true urban character. Function and form are the essentials of the matter. The word *urban*, as opposed to *rural*, implies an activity that is divorced from the cultivation of the soil and that is carried out in close association with kindred activities at fixed places. These activities, in the broadest sense, are cultural (especially religious), commercial, industrial, administrative, and residential (in the sense of non-producers or *rentiers* who are dependent on the urban dwellers and the countryside). Farming, however, is not excluded from the occupations of the urban community. A farming element is particularly characteristic of the towns of

† For a general summary of the status of urban geography, with full bibliography, see H. Dörries, "Der gegenwärtige Stand Stadtgeographie," *Petermanns Mitteilungen, Ergänzungsheft*, Nr. 209, 1930, pp. 310-25. See also the following: W. Geisler, "Beiträge zur Stadtgeographie," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, 1920, pp. 274-97, and "Zur Methodik der Stadtgeographie," *Petermanns Mitteilungen, Erganzungsheft* Nr. 214, 1932, pp. 39-47, M. Aurousseau, "Recent Contributions to Urban Geography: A Review," *Geographical Review*, Vol. 14, 1924, pp. 444-55; and "The Distribution of Population: A Constructive Problem," *Geographical Review*, Vol. II, 1921, pp. 563-92, Raoul Blanchard, "Une Methode de Geographie Urbaine," *Revue de Geographie Alpine*, Grenoble, Vol. 16, 1928, pp. 193-214, first published in *La Vie Urbaine*, Paris, 1922, pp. 301-19, and H. Bobek, "Grundgragen der Stadtgeographie," *Geographische Anzeiger*, Vol. 28, 1927, pp. 213-24. A recent brief, but comprehensive study of the geography of cities is G. Chabot, *Les Villes*, Collection Armand Colin, Paris, 1948.

* Visiting Professor of Geography, Syracuse University.

[1] It should be emphasized that this is essentially a bibliographical study and attempts to sum up the general trend in concepts and techniques in urban geography as revealed in a very considerable literature over the last fifty years, and especially in the inter-war period. It is in the interest of brevity only that references are confined to works mentioned in the text. It should also be pointed out that the article is written with special reference to Europe.

the Mediterranean lands and of east central Europe; it was important in the origin of the early medieval towns of western Europe, though it dwindled as trade and industry grew, and it is still not unimportant in many semi-urban towns on the continent.

The specifically urban activities are all located either so as to serve a surrounding territory or to carry out activities that are tied down to certain resources or where such resources can be conveniently assembled. Such activities may be carried out separately at different places. This occurs in the beginnings of permanent settlement and also in thinly-populated or backward areas, where such settlement may assume a semi-permanent character. In the forested lands of north Sweden there are churches around which cluster timber buildings that are occupied only during the seasonal fairs. The tribal markets of Morocco are temporary settlements. Specialization of urban functions as between one place and another is a marked feature in the lands of western civilization, owing to the development of transport facilities, and takes the form, for example, of an isolated factory, a group of workers' houses in the open country, a mining camp or a seaside or inland resort. All these may be described as *urban settlements*. When, however, these activities occur in some kind of combination in a permanent and compact settlement with some measure of community organization, the place assumes the character of a *town*. A *city* is a king among towns, enjoying leadership over its neighbors. A fundamental trait of both town and city in all ages has been that they are institutional centers (commercial, cultural, and administrative) for their surrounding territory. It is only in recent times that industry has become a primary cause of urban growth. Upon the basis of regional service and industry there grows a pyramidal structure of secondary occupations, catering to the needs of these specialist occupations and to the personal needs of the inhabitants.

In virtue of its distinct activities, the lay-out and the buildings of the urban settlement are also distinct from the rural settlement. The urban activities are accommodated in shop, workshop, office, warehouse, and public building, and find their mutual and outside contacts by street, road, river and latterly, by rail. The dwellings of the workers and their dependents normally take up most of the built-up area. All these are the form-elements of the settlement group. The problem of the geographer is to determine not only the distinctive functions of the urban settlement, but also how its form-elements are arranged in relation to each other and to the streets and places. Generalization cannot safely be applied to all climes and times and we confine our comments to western Europe. Thus, in England, the simplest urban functions appear in an occasional village in special buildings that are scattered among the houses along the village streets. Even the small English village is primarily a service center for the dispersed farmsteads around it and itself contains very few farmsteads. More of these urban functions are concentrated in the small town, which normally has its nucleus in a market place or a wide main street of medieval origin, on which the urban buildings form a continuous frontage. The larger the town the more the buildings, and these spread from the nucleus along the main streets and special functions seek special sites. The railway station invariably has become a nucleus of segregation. In the large town the urban functions are so numerous and varied that they compete for space as near as possible to the nucleus so as to form a central district that throbs with

activity in the day and is a "deadheart" at night. This core, that is popularly called the "town" or "city" or "downtown," together with the commercial sub-centers and the clusters of factories, forms the main areas of work that are separate from the areas of residence in which the workers live. The existence of the core and the marked separation of areas of work and residence is the most distinctive feature of the structure of the large city as opposed to the smaller town.

Finally, these characteristics of urban settlements, their size, functions, spacing, lay-out and build, vary regionally with the physical environment, with the density of population, and with the character of the human economies and cultures which they serve and represent. There are vast differences in urban settlement between the English Lowland, the Ganges Plain, and the Australian Riverina. There are also important differences in urban character between different areas of western Europe. Most of these features of settlement are obvious to any careful observer. Their scientific examination and the elucidation of their regional variations both over wide areas and within the urban complex itself are essential problems of urban geography.

The geographical study of an urban settlement is concerned with four main problems: first, the physical and cultural conditions that were involved in the origin of the nucleus of settlement; second, the reactions of this nucleus, in its functional and morphological development, to the impact of historical events; third, the life and organization of the contemporary settlement viewed areally, both as a whole and with respect to the differentiations within it; fourth, the interrelations between the settlement and its surrounding territory. These four problems are concerned with the study of the individual settlement. There is, however, a further important aspect of study, namely, the comparative aspect. The size, function, and form of all settlements vary regionally with the development and present social and economic structure of the human groups which they represent and serve, and it is for the geographer to investigate those features of the urban settlement that are really repetitive and significant just as he studies the rural settlement. In other words, as in the field of geomorphology, the geographical study of human settlements both rural and urban has three aspects. There is the *physical structure* of the settlement—the character and mode of grouping of its buildings and streets; there is the *process* which determines this structure—that is, the social and economic character and traditions of the community; and third, there is the *stage* in the historical development of the settlement. This historical or developmental treatment may lay equal emphasis on each phase of development (especially when different civilizations have produced entirely new structures on the same site), but the final aspect of the study, to which all else should be subordinated, is the depiction and interpretation of the settlement of today, both as a whole and as to its component parts.

2. Site and Situation

The first task of the geographer in an urban study is to determine exactly the characteristics of the site and situation of the settlement. The *site* embraces the precise features of the terrain on which the settlement began and over which it has spread. This study demands thorough examination of the initial site that so often has been profoundly modified by human action, especially in the large city. It includes such matters as relief, geology, water supply, the nature of the river that traverses the settlement, and the areas

originally liable to flood before embanking, etc. The *situation* is usually taken to mean the physical conditions (as for the site) over a much wider area around the settlement. But of equal importance are the human characteristics of the surrounding country since these affect the character and fortunes of the urban settlement. The term nodality is used by geographers to express the significance of a settlement as a node or focus of routes. Hitherto, the geographer has been too prone to assess the position, size, and functions of the urban settlement in terms of the "natural routes" centered on it. The nodality of a settlement is to be measured neither in terms of the physical setting, nor simply by the number of man-made routes that radiate from or pass through it but, ultimately, by the traffic of all kinds that uses these routes. In other words, nodality should be measured on the basis of the functions of the settlement as a focus. We need a measure of such centralized or nodal functions in terms of the relations of the settlement with the country and with other settlements around it.

These points may be illustrated by specific references to the towns of Western Europe.[2] There is no doubt that the situation of the town, in relation to routes and to the fertility of its surrou nd ings, had a close relation to its size down to the industrial era. Indeed, with a few exceptions, the chief towns at the beginning of the 19th century were situated at the junction of the main road and water routes, and these towns and routes almost all date back in origin to the early middle ages. Long distance trade was the primary factor in the development of the early medieval towns. It called into being many mercantile settlements on the main routes, although the chief of these settlements clustered for protection and custom around existing strongholds that already served as seats of defense and administration for their surrounding territories. The growth of handicrafts and of local trade caused these settlements to develop ever closer associations with their surroundings. By 1150 the concept of the town or *civitas* was fully established. It is true that the merchants played a predominant part in the government of the medieval town, but this does not warrant overemphasis of the importance of this element in their origins. Long distance trade, local market trade, defense and administration all played their part, and their relative importance varied at different stages in urban development from one region to another.[3]

The development of towns in the early middle ages (before 1200) was favored on valley and lowland sites at the junction of valley routes because facilities for trade and for the organization of the populated area and contact with the civilized world were primary factors in their location and growth. In the later middle ages (after 1200) the great majority of towns grew as local centers of trade and administration and had only local nodality. Their sites were dictated by the need of defense rather than trade, and either castle or town, or both, were placed on strongly defended natural sites such as hill tops and river spurs. Whatever the origin of these small towns, however, it is quite clear that their survival or growth as active urban centers before the modern era depended entirely on their ability to function for a tributary area in competition with neighboring towns of similar status.

The advent of the railway in the middle of the 19th century added an entirely new

[2] Robert E. Dickinson, "The Development and Distribution of the Medieval German Town," *Geography*, Vol. 27, 1942, pp. 9-21 and 47-53.

[3] There are numerous careful studies, both by geographers and historians, of the development of urban settlements in different regions of Germany. For bibliography see Dickinson *op. cit.*

element to the nodality factor and radically transformed the structure of the growing urban settlement. The original conditions of the site and situation became of historical significance and were displaced by the new means of communications and the new needs of industry and commerce. But the great majority of towns are still small and have changed little in size from a hundred years ago. The modern city has spread from its original nucleus. Down to the latter half of the 19th century the continental cities were still confined within their fortifications. The walls of many towns were demolished and replaced by boulevards in the early years of the 19th century. Others were surrounded by entirely new fortifications to meet the demands of modern warfare or to serve as customs barriers (*octroi*), and these set very real limits to urban expansion until they in turn were replaced by boulevards, buildings, and open spaces. The old town is usually in the heart of the city. In the case of the small towns with defensive sites, the nucleus, be it a castle or town on a hill top or on an island girt by marsh, is separate from the new extension which has grown along a road or near a railway.

3. Historical Development

Once having determined precisely the physical conditions of situation and site which affected the beginnings of the urban settlement the geographer examines how, with the passage of time, the settlement utilizes, adapts itself to, and transforms these conditions in the process of its formation and expansion. History must be made subsidiary to this main object. This point is important. Many urban studies, especially in Britain, have traced the historical character of the adjustments of the settlement to the physical conditions of its site and situation and, for that reason, do not give a clear picture of the present physiognomic and functional structure of the settlement as an entity in space, which, as stated above, we believe to be the central object of the study.

A word should be said here about the formation of the individual town in Western Europe. The urban geographer's task commences with the appearance of the first traces of permanent settlement. The disputed question of urban origins is one which is more obscured by vagueness as to what is meant by urban. The historian is concerned with the emergence of the community as a self-governing body and usually confines his attention to the principal medieval towns. H. Pirenne defined a medieval town as having three characteristics—its population was engaged in industry and commerce, it had a distinct legal constitution and institutions, and it was a center of administration and a fortress.[4] These were certainly true characteristics of the fully-fledged town, but such a definition of all urban settlements in selected areas would be quite inadequate and untrue. In attempts to generalize as to the origin and character of the medieval town, historian and geographer have failed to realize adequately that single traits of the fully-fledged medieval town occur in small towns and villages as separate elements and there is, therefore, no clear cut distinction between the two. There were, in the middle ages, towns without walls, towns without markets, villages with walls, and villages with crafts and tradesmen without the legal constitution of a town.

The route and market place formed the nucleus of the early medieval towns which usually grew adjacent to a stronghold from which the growing urban com-

[4] H. Pirenne, *Medieval Cities, Their Origin and the Revival of Trade*, translated by F. D. Halsey, Princeton, 1925.

munity eventually wrested its independent status. The majority of towns, however, especially west of the Rhine, grew gradually around a castle, a church, or a monastery, whereas in Germany they were founded as self-contained and self-governing communities with planned forms attached to, or independent of, an existing nuclear stronghold. Such founded towns appear also in the numerous *bastide* towns of southwestern France and, more sporadically, in the towns that were founded by the English in the conquered territories of Wales. The expansion of the medieval town was conditioned by the main through and radial routes, by the walls, and by the necessity of adjustment of street and block to the lie of the central monuments, such as castle or cathedral. This growth was the result either of uncontrolled expansion, house by house, or of planned expansion in which the disposition of the houses was fixed by a pre-determined street lay-out.

The broad historical events decisive in the history of urbanism are common to Western Europe. The end of the Roman civilization was followed by a period of decadence for over five hundred years. The great phase of medieval growth of the "ecumene" began with the turn of the millenium and by 1500 Western Europe was covered by practically all the settlements that exist today. The Renaissance and Baroque periods, from 1500 to 1850, were periods of relative stability. Towns in general grew little but changed much in aspect by the erection of new permanent domestic buildings, new public buildings, gardens and avenues and the new bastioned walls that were made necessary by the advent of gunpowder. New towns or extensions of old ones were laid out on geometrical designs in accordance with the spirit of the age, as has been so vividly portrayed by Lewis Mumford. The southern steppes of Russia and the lower Danube lands saw the appearance of many towns in the 17th and 18th centuries and a number also were founded in southern Scandinavia and east central Europe, especially in Poland and Finland.

The "eotechnic" merges into the "paleotechnic" era with the advent of the factory with machinery driven first by running water and later by steam. This era brought the "back-to-back" house to Britain and the tenement to Europe. The end of the 19th century ushered in the "neotechnic" era, marked by the decline in the rate of growth of population and of cities, by the advent of the electric dynamo and the internal combustion engine, and by the increased rapidity of municipal transport. These changes have occasioned the "explosion" of the urban aggregate through the expansion of both residence and industry well beyond its administrative limits, and the emergence of particular urban structures on new sites, that are apparently unconnected with other urban structures. All these facts form the background to the understanding of the growth and structure of the European city.[5]

These historical phases are evident in the physical structure of almost every west European city as a series of more or less concentric zones. The central zone, the modern business district, is, for the most part, the historic town (medieval and baroque) that is in process of rapid transformation. The middle zone was built up during the latter half of the 19th century and is fully occupied by streets and buildings. It is congested with mixed uses near the center, but becomes more open and predominantly residential towards the margins. The outer zone has been built up since 1900 on the periphery of the city, where urban struc-

[5] Lewis Mumford, *Culture of Cities* (New York: Harcourt Brace, 1938), and *Technics and Civilization* (New York: Harcourt Brace, 1934).

tures are widely scattered along the main routes in the midst of rural land. Factories, housing estates, urban open spaces (cemeteries, allotments, playing fields, golf courses, airfields) and noxious industries are its chief urban uses. Expansion outwards has been a basic characteristic of urban growth in all eras and this also implies a succession of types of land-use as part of the process. Thus, good residences were initially placed on higher land or on river fronts near the old town. With the expansion of the town the good residences have shifted outwards and the old ones have been invaded by other uses and converted to apartment houses or offices.

Recent studies differ considerably in emphasis according to the viewpoint of the particular school. Thus, some German studies depict with equal emphasis the build and activities of the town at each main stage in its development, an approach that is particularly significant in cities that have been completely destroyed and transformed with the passage of different cultures. This approach is well demonstrated in Wilhelmy's study of Sofia.[6] It is more usual to subordinate the study of the past to the understanding of the present, a historical approach that is particularly characteristic of French studies.

4. Structure

It has been stated already that the present urban settlement is the culminating and the central object of the geographical approach. "Apres l'etude dans le temps, l'etude dans l'espace" writes (and practices) Raoul Blanchard.[7] There are two aspects of such study, the functional and the demographic structure of the city; and the plan and build or morphological structure of the city. These are intimately interrelated and permit the recognition of homogeneous functional zones or regions. Functional study within the urban complex involves the classification and mapping of land uses, of building types, of industry and commerce, of the density and occupations of the population, and of the density of traffic on roads and at nodal points. Classification, field methods, and cartographic techniques are essential to all aspects of such study. It is an approach that hitherto has been the peculiar concern of the geographer, but is becoming a matter of particular interest today to all those who are interested in the structure of the city.

This geographical approach may be illustrated by a preliminary reconnaissance survey recently carried out under the writer's direction by a group of students in the lower Wye Valley, Monmouthshire, England. The town to be mapped had about 5,000 inhabitants. Three maps were prepared. Firstly, the site and situation were studied in the field and mapped from the Ordnance Survey map with a scale of about 25 inches to one mile, with contours at intervals of 25 feet. The land liable to flood was also determined. Secondly, the buildings were mapped by age, by marking individual buildings and groups of buildings by periods on the 25-inch map. This was done by inquiry from local authorities, by deduction from building styles, and by the study of old maps that were available. Thirdly, buildings were mapped on the same scale according to use. In such a small town it was found

[6] H. Wilhelmy, *Hochbulgarien, II, Sofia; Wandlungen einer Grossstadt zwischen Orient und Okzident,* (Schriften des Geographischen Instituts der Universität, Kiel, Band 5, 1936).

[7] Raoul Blanchard, *Grenoble: Etude de Geographie Urbaine* (Grenoble: 1912), reprinted and augmented, 1935, and "Quebec: Esquisse de Geographie Urbaine," *Revue de Geographie Alpine* (Grenoble: 1934), pp. 216-413, may be referred to as outstanding studies from the French school. From the German school, see H. Bobek, "Innsbruck: eine Gebirgstadt, ihr Lebensraum and ihre Erscheinung," *Forschungen zu deutschen Landes und Volkskunde* (Stuttgart: 1928).

that certain types of structure were recognizable and these were plotted with different colors and digits as follows:

1. Public buildings, with a digit for each type of function.
2. Buildings of three stories and over with two or more stories in commercial use.
3. Buildings with one or two stories with one or both stories in commercial use.
4. Buildings with three stories with one story in commercial use. Digits indicate the type of use in each case (2, 3 and 4), thus: (a) shop, (b) office, (c) bank, (d) cafe, (e) garage, and (f) others.
5. Cottages.
6. Detached or double fronted residential houses built prior to about 1900.
7. Town houses with three stories.
8. Town houses with two stories.
9. Post-1918 houses.
10. Factories, grouped according to product and indicated by digits.
11. Commercial premises, shown by a special color with digits as follows: (a) warehouse, (b) mills, (c) storage yards, (d) garage, (e) railway goods yards, and (f) others.

The three provisional maps gave at a glance the site, the layout and the expansion of the town, while its functional structure and activities were clearly evidenced in the character of the buildings and their uses.

We may turn now to more elaborate studies that obviously demand much labor and, in the case of large cities, team work under central direction. There are many geographical studies of individual cities; but particular attention may be given to a study of Stockholm, a relatively small city with little more than half a million inhabitants, that was prepared in 1934 by a group of geographers in the University of Stockholm on behalf of the municipal authorities.[8] Important examples of mapping technique will be found there. Industry and commerce may be classified and mapped according to the type of building unit (floor space, the number of stories, or transport facilities), the type of product (involving classification on an agreed basis), or the number of employees for each factory unit. The density of population may be mapped for the smallest available unit areas by a graded system of shading or by a dot value,—the effective use of the latter, for accurate work, involving mapping block by block. Detailed mapping of ethnic, demographic, and occupational data also demands small statistical units. For all such work the British ward or its equivalent in foreign cities is far too large for research purposes. An example of unit required is the so-called "census tract" of the United States Bureau of the Census that covers a few blocks in the urban area. In Chicago, for example, there are 500 census tracts whereas before 1920 the same city only had 34 wards for statistical analysis. Continental cities have occasionally small districts comparable with these that permit thorough mapping.

The social and economic status of the inhabitants can best be indicated by house rentals, where these are available for sufficiently small districts. Streets may be classified according to the type of shops and traffic. This is determined in the Stockholm study, for example, by adding the shop rents of the street frontage and dividing the total by the length of the frontage; this gives the shop rent per unit of frontage and is a measure of the shopping density of the street. These varied aspects have been examined and mapped in the study of Stockholm mentioned above and, in order to determine the shifts of urban uses and the processes accounting for them, the distribution of activities was mapped for 1880, the beginning of the rapid development of the modern city and, for 1930, most of

[8] H. W.: son Ahlmann, and others, *Stockholms Inre Differentiering, Meddelande fran Geografiska Institutet vid Stockholms Högskola* (Stockholm: No. 20, 1934). Also W. William-Olsonn, "Stockholm: Its Structure and Development," *Geographical Review*, Vol .30, 1940, pp. 420-38.

the activities being mapped by exact locality by a dot indicating a particular use, such as a bank or office.

Building structures need to be classified and mapped on the lines, for instance, of H. Louis' Study of Berlin.[9] In this study, which was undertaken in the field by a group of students, the whole city was mapped as follows: (1) uniform buildings of four stories and over (mainly tenements), (2) varied building structures occurring in both the central and outer areas, (3) villas, housing estates and gardens, (4) factories, shown in ground-plan, (5) allotments (*Laubenkolonien*) and meadows (*Rieselfelder*) fertilized with sewage waste, (6) villages, and (7) the limits of the central business district.

It is now being increasingly realized that this geographical method is essential to the understanding of the anatomy of the urban community preparatory to planning for its reconstruction. Where such investigations have been undertaken on a large scale in the last twenty years (as in the city inventories of Chicago and New York in the United States) the results are accessible in large publications which, in the case of New York, for example, have been summarized in an admirable geographical essay on that city.[10]

5. *The Limits of the Urban Settlement*

The urban settlement cannot be interpreted adequately as a mass of materials or in terms of dead patterns. It must be interpreted as an organic part of a social group.[11] In terms of its four functions—dwelling, work, recreation, and transport—every urban settlement forms part of an economic, social, cultural, and political whole, upon which its development depends and all these relations have geographic expression.[12]

Viewed in this way the urban settlement in general has a two-way relationship with its surroundings that extends beyond its political boundary. First, the countryside calls into being settlements that we call urban to carry out functions in its service. Second, the urban settlement, by the very reason of its existence, influences, in varying degree, its surroundings through the spread of its network of functional relations and the expansion of its settlement area. This regional factor varies greatly. In some cities, like historical regional capitals, market towns and country capitals, it is highly significant; while in others, especially in specialized urban communities that owe nothing directly to servicing the countryside, such as industrial settlements and health resorts, the regional component is at a minimum.

While this is a general urban phenomenon, it is particularly true in the United States, where entirely new settlements have grown in recent years around one or more large industrial plants. Endicott in New York and Hershey in Pennsylvania are examples. The urban structures tend to be separate from each other, and urban cohesion develops through the establishment of public utility services (gas, electricity, water, drainage, sewage disposal), and transportation services which are not general in supply or coincident in distribution. The urban settlement has exploded, functions existing separately in separate places, so that new problems arise in providing those common services and institutions that are needed for an efficient and happy community life.

[9] H. Louis, *Die Geographische Gliederung von Gross-Berlin* Stuttgart: Engelhorn, 1936), 26 pp. with two maps.

[10] J. K. Wright, "The Diversity of New York City," *Geographical Review*, Vol. 26, 1936, pp. 620-39.

[11] M. Aurousseau, "Recent Contributions to Urban Geography," *Geographical Review*, Vol. 14, 1924, pp. 444-55.

[12] J. L. Sert, *Can Our Cities Survive?* (Harvard University Press: 1943).

Two problems arise in this connection; first, the assessment of the ways in which the urban settlement acts as a regional focus and how these activities are reflected in its functional structures and its build; and second, the geographical range and potency of the activities of the urban settlement with its environs. These functional relations are concerned with the housing of workers outside the political limits; with the factories planted on its outskirts; with the inward movement of food supplies (especially perishable foods like milk and vegetables), raw materials and manufactured goods for collection, consumption and redistribution; with the outward movement of goods, both consumers' goods and producers' goods, and of services—commercial, educational (schools, newspapers, cultural organization), and administrative; and with the range of supply of public utility supplies, which frequently extends beyond the urban area.

The geographer is not so much concerned with the precise analysis of particular service areas; for this is ultimately a problem of marketing for which the economist is more qualified. He is more concerned with the ways in which these relationships are reflected in the functional and physical structure of the town. From this point of view, certain facts are outstanding as fixing the limits of the urban complex. Chief of these is the limit of the urban built-up area. Such an area when embracing several contiguous administrative districts was called by Patrick Geddes an "conurbation," and the idea has been elaborated by C. B. Fawcett.[13] This term, however, is inadequate for the geographer since, by definition, it is not generally applicable to all large urban settlements; moreover, it implies no minimum limit in area or population. There is no *a priori* justification for taking 100,000 inhabitants as the minimum limit, and there are many urban areas that lie well inside one political unit. Since the geographer is concerned primarily with the urban settlement as an expression of man's activities on the earth's surface, an alternative term is needed to embrace the whole built-up area, and we suggest the term *urban tract*, to equate with Unstead's definition of a tract in a proposed system of regional units.[14] The tract is characterized by the marked differentiation of structures from one area to another just as Unstead's tract, defined in more general terms, contained a number of primary landscape units that he called "stows." Beyond this compact urban tract there is a zone with intimate social and economic relationships with it. It is the area of regular deliveries of comsumers' goods and of daily movements of people to the center for business and shopping and to the industrial districts and elsewhere for their daily work. G. Chabot calls it, in reference to Dijon, the *zone du voisinage*.[15] We may refer to it as the *urban settlement area*. It is marked by a steadily rising population, as opposed to a slow increase or decrease in the urban area and a decrease in the rural areas on its fringes, and by its relatively high density of population in contrast to the rural areas encircling it. A large proportion of its residents are also engaged in daily work in the urban area and in factories in its

[13] P. Geddes, *Cities in Evolution* (London: 1915); and C. B. Fawcett, "British Conurbations in 1921," *Sociological Review*, Vol. 14, 1922, pp. 111-22; and "The Distribution of the Urban Population in Great Britain in 1931," *Geographical Journal*, Vol. 79, 1932, pp. 100-16.

[14] J. F. Unstead, "A System of Regional Geography," *Geography*, Vol. 18, 1933, pp. 175-87.

[15] G. Chabot, "La Determination des Courbes Isochrones en Geographie Urbaine," *Comptes Randus du Contres Internationale de Geographie, 1938, Tome 2, Geographie Humaine*, pp. 110-3. See also H. Hassinger, "Beiträge zur Siedlungs- und Verkehrs-geographie," *Mitt. der K. K. Geog. Ges. in Wien*, Band, 53, 1910, pp. 5-94, with two maps on a scale of 1:200,000. The latter was a pioneer study.

vicinity.[16] Accessibility is the primary determinant of these areal relations and geographers have paid much attention to the preparation of isochronous maps showing zones of equal time accessibility to selected points in the city center. Beyond this urban settlement area there is a wider area which is mainly oriented towards its local towns but has occasional contacts with the distant city, which functions as the regional center. This may be called the *city-region*. Many geographical studies on all these aspects of the city have appeared in the interwar period.[17]

6. *Comparative Studies: Functional*

The comparative study of the location, spacing and size of towns as commercial centers was attempted by the German, J. G. Kohl, a hundred years ago.[18] While the works of F. Ratzel and F. von Richthofen, through their refinement of the conception of geography, gave some stimulus to the further study of cities, K. Hassert, A. Hettner, and O. Schlüter around 1900 put the subject on a firm footing with regard to its main aims and methods. Hettner (1895 and 1902) stressed the need for functional classification of towns and for mapping the distribution of towns at different epochs according to their functional character. He also emphasized the varying effect of location (*Lage*) and cultural and economic conditions on the character of cities from epoch to epoch and from country to country.[19]

Many attempts have been made by geographers to classify towns according to their functions. One of the most stimulating essays of this type by M. Aurousseau[20] divided towns into six groups classed according to their dominant functions: administration (capital cities and revenue towns), defense (fortress, garrison, and naval towns), culture (university, cathedral, art and pilgrimage centers), production (manufacturing towns and craft centers), communications (classed according to the main function as collection, transfer, and distribution centers), and recreation (health, tourist, and holiday resorts). The communication group was further divided as follows: collection centers—mining, fishing, forest and depot towns; transfer centers—market, fall-line, break-of-bulk, bridgehead, tidal-limit, navigation-head towns; distribution centers—export, import, and supply towns. But in all urban settlements there is a mixture of two or more primary functions and it is impossible to assess the importance of each consistently on the basis of statistics of occupation, for the selection is based partly on a subjective appraisal of the tone or character of the place. Nevertheless, this method gives a basis for classifying and mapping urban settlements over wide areas, and a first attempt on these lines has been made recently for the United States, in which all the towns with over 10,000 inhabitants are classed on a statistical basis as manufacturing, retail, diversified, wholesale, transport, mining, university, and resort towns.[21]

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[16] R. Clozier, *La Gare du Nord* (Paris: 1941), is a thorough study of the *banlieue* of Paris with special reference to the northern districts served by the Gare du Nord.

[17] Robert E. Dickinson, *City, Region and Regionalism* (London: Kegan Paul, and New York: Oxford University Press, 1947). Paris has been studied with particular thoroughness from the point of view of its food supplies. See, for example, R. Dubuc, "L'Apportionment de Paris en lait," *Annales de Geographie*, Vol. 47, 1938, pp. 257-66 and P. Gallet, "L'Approvisionnement de Paris en vin," *Annales de Geographie*, Vol 48, 1939, pp. 359-68, and R Clozier, *op. cit.*

[18] J. G. Kohl, *Der Verkehr und die Ansiedlungen der Menschen in ihrer Abhängigkeit von der Gestaltung der Erdoberfläche* (Leipzig: 1841).

[19] A. Hettner, "Die Lage der menschlichen Ansiedlungen," *Geographische Zeitschrift*, Vol. I, 1895, pp. 361-75, and "Die Wirtschaftlichen Typen der Ansiedlungen," *Geographische Zeitschrift*, Vol 8, 1902, pp. 92-100.

[20] M. Aurousseau, "The Distribution of Population: A Constructive Problem," *Geographical Review*, Vol. II, 1921, pp. 563-92.

[21] C. D. Harris, "Functional Classification of Cities in the United States," *Geographical Review*, Vol. 33, 1943, pp. 86-99 .

This method of classification is based upon an estimate of the primary functions of the town. The town, however, owes much of its essential character to the needs of its service area and the functions it performs for it. Thus, attention has been given recently to the assessment of the centralized or regional functions of the town, and the local services which cater primarily to its inhabitants. This idea has been elaborated by W. Christaller, a German scholar,[22] with regard to the distribution, size, and functions of the towns of south Germany, and there are similar studies by other German scholars. A correction to Christaller's rather one-sided conclusions is offered by H. Bobek,[23] who rightly points out that there are big variations in the importance of the centralized functions between town and town, and from one region to another. Further work on this aspect of the functional structure of towns will assist in the planning of new urban communities. Examples are A. E. Smailes' recent studies of towns in England and Wales.[24]

The port is a special class of urban community and we wish here to emphasize the close relations that exist between its functions and structure and the territory which it serves, that is vaguely referred to as its hinterland. In an excellent study on hinterlands A. J. Sargent[25] refutes the idea that a hinterland can be bounded by lines. He rightly asserts that it is an economic rather than a geographical concept, and that each of the specialized services of the port serves places that may in no sense correspond with each other, just as the places of supply and distribution of the commodities of the manufacturing center are not necessarily coincident in their geographic distribution. Indeed, we would maintain that this wide field of study is geographical economics rather than economic geography and lies within the particular competence of the economist. But it is not fair to assume that the specialized geographer is guilty of such naive assumptions, for Sargent fails to draw attention to the admirable study of the late Alfred Ruhl,[26] a German geographer of repute, on precisely this question with special reference to the German ports, and to L. Mecking's studies of the Japanese ports,[27] as well as to J. H. Schulze's interesting classification of English ports in terms of their predominant functions.[28]

7. *Comparative Studies: Morphological*

The final aspect of comparative urban geography is one that has received virtually no serious attention from English-speaking geographers. This may be described as urban morphology, that is, the study of the lay-out and build of towns viewed as the expression of their origin, growth, and function. Much work of inferior quality has appeared in this field, because the approach has been empirical rather than genetic, and it is the latter only which permits the recognition of the significant. The study is the precise parallel of the study of rural

[22] W. Christaller, *Die Zentralen Orte Suddeutschlands* (Jena: 1932).

[23] H. Bobek, "Uber einige funktionellen Stadttypen und ihre Beziehungen zum Lande," *Comptes Rendus du Congres Internationale de Geographie, 1938, Tome 2, Geographie Humaine,* pp. 88-102.

[24] A. E. Smailes, "The Urban Hierarchy in England and Wales," *Geography,* Vol. 29, 1944, pp. 41-51, "Urban Fields and Their Delimitation," *Geography,* Vol. 33, 1948, and "The Urban Mesh in England and Wales," *Transactions of the Institute of British Geographers* (London: 1947), and Robert E. Dickinson, "The Commercial Functions of the Nuclei of the English Conurbations," *Sociological Review,* Vol. 21, 1929, pp. 38-49.

[25] A. J. Sargent, *Seaports and Hinterlands* (London: 1938).

[26] A. Rühl, *Die Nord und Ostseehäfen im deutschen Aussenhandel,* Berlin, *Veröff. d. Instituts f. Meereskunde,* Neue Folge, (15 maps), Heft 3, 1920.

[27] L. Mecking, "Die Seehäfen in der geographischen Forschungen," *Hermann Wagner Gedachtnisschrift* (Gotha: 1930); and "Die Grosslage der Seehäfen insbesondere das Hinterland," *Geographische Zeitschrift,* Vol. 37, 1931.

[28] J. H. Schulze, "Die Häfen als Glieder der Kulturlandschaft," *Festschrift für Prof. G. W. Zahn,* 1931; and *Die Häfen Englands* (Leipzig: 1930).

settlements that has figured so prominently in French and German geographical researches in the last twenty years.

The investigation of the plan and build of towns began to be systematically undertaken about fifty years ago. The relevant aspects of study in an individual town embrace the lay-out of its streets and blocks considered in relation to public buildings, terrain, and natural (uncontrolled) and planned growth. The precise site and lay-out of the initial settlement and the mode of its extension from this nucleus are analyzed in close conjunction with historical development. Indeed, historians have found evidence for the mode of growth of a town in its plan which is often far more informative than an ancient document. The buildings are mapped and interpreted from the standpoint of their age, architectural style and function. It is significant that in Germany most of the work on styles and materials has been done by other specialists, whereas studies of forms or structures have been the particular concern of the geographer.

Comparative study of German towns reveals historic and modern house types. The principal historic types are the gable house (*Gabelhaus*), with gable fronting the street, of several stories, and narrow street frontage, and the eves house (*Traufenhaus*), with its gable parallel to the street frontage. The origin of these two distinctive house types that still affect the whole aspect of the old towns of Germany is still somewhat obscure. It seems, however, fairly conclusive that they developed during the middle ages out of the traditional farmsteads of north, central, and upper Germany in order to meet the needs of the new urban economy and building requirements. The gable house was the rule in northern Germany and the eaves house in the south. The classic instances of the former are found in the Hanseatic coastal towns. The eaves house was not a post-medieval growth as has been often asserted, for it was adopted in the initial founding of Freiburg-im-Breisgau in the 12th century and was in the many other towns in the south German lands that were founded after it, such as Bern and Freiburg in Switzerland. With the appearance of Italian Renaissance influences in the 16th century, and with the need for increased economy of space and protection from fire, the eaves house was adopted generally, and the house with its gable fronting on the street was actually forbidden in the by-laws of most of the large cities. Among the modern types, the house with a more rectangular ground-plan and a mansard roof is characteristic of the Baroque era in the 17th and 18th centuries. Other types are the *Langhaus*, a long eaves house, with saddle roof and small depth, the *Firsthaus*, with two stories and like the *Langhaus* except for its greater depth, the lodging house (*Miethaus*), small and rectangular with an adaptation of the mansard roof in the south and west of Germany, a large barrack-like tenement (*Kastenhaus*) in the north and east of Germany, and the better standard apartment house with variously ornamented facades (*Etagenhaus*).[29]

There are many studies of building structures in particular towns. Geisler's early studies of Danzig may be quoted. Houses were mapped in 1918 on a scale of 1:10,000 in three categories, one or two stories, three stories, and four or more stories, and separate colors were used to to show transport and adminstrative buildings, churches, schools, and military buildings, main shopping thoroughfares, warehouses, and factories. In a second study in 1922 Geisler mapped four

[29] W. Geisler, "Die Deutsche Stadt" *Forschungen zu deutschen Lande und Volkskunde* (Stuttgart: 1924).

house types, the *Giebelhaus*, with a high gable facing the street frontage (15-17th centuries), the *Langhaus*, with a high roof (18-19th centuries), and the *Kastenhaus* and *Etagenhaus* of the late 19th century.[30] A similar classification of houses based on roof types will be found in a more recent study of Breslau.[31] H. Hassinger many years ago carried out a survey of the buildings of Vienna in which he recognized seven architectural periods beginning with the 12th century.[32] A particularly interesting French study of houses in the city of Rouen has been undertaken more recently by a specialist in geography and architecture and should stimulate kindred study in other towns.[33] A section on house types appears in most French town studies. Attention is also drawn to studies by American geographers who have taken an increasing interest in recent years in the morphology of settlement, both in the United States States and elsewhere. We note, in particular, J. B. Leighley's initial study of the morphology of a group of Swedish towns and his more recent study of the medieval towns of Livonia, that is, of Estonia and Latvia.[34]

Fifty years ago,[35] Otto Schlüter advocated the need for comparative morphological study of towns. He drew attention, for example, to the contrasts between the towns of western Germany that were often the result of gradual, uncontrolled growth, and the towns of eastern Germany that were frequently planned entities with rectilinear forms. Such investigation was stimulated directly by the researches of Meitzen into village origins. In this connection mention should be made of the many detailed comparative studies of towns that have been undertaken by German historians and architects for such large areas as Brandenburg,[36] northern Germany,[37] Bohemia,[38] southern Germany,[39] and the State of Brunswick.[40] From such studies, as well as from their independent investigations, German geographers have made a substantial contribution to the understanding of urban morphology. W. Geisler, in a work previously noted, attempted to classify German towns according to site, plan, and build.[41] A more thorough and convincing interpretation on these lines, based on preliminary studies of the towns of Westphalia, is R. Martiny's essay on the morphology of German settlements.[42] He groups all settlements, both rural and urban, into *natural forms* that are the result of gradual growth without preconceived planning, and *planned forms*. The natural forms include irregular plans

[30] W. Geisler, *Danzig: ein Seidlungsgeographischer Versuch*, Inaugural Dissertation (Halle-Wittenberg: 1918); and *Die Weichsellandschaft von Thorn bis Danzig* (Hamburg: 1922); with colored map, scale 1:10,000.

[31] E. Müller, *Die Altstadt von Breslau: City Bildung und Physiognomie, Veröff. der Schlesischen Ges. für Erdkunde* (Breslau: 1931).

[32] H. Hassinger, Kunsthistorischer Atlas von Wien, *Oster, Kunsttopographie*, Band 15 (Vienna: 1916); with 19 colored plans; "Kartographische Aufnahme des Wiener Stadtbildes," *Mitt, der K. K. Ges. Wien*, Band 58, 1915, *Kunsthistorischer Plan des I Bezirks der Stadt Wien*, Scale 1:10,000, (Vienna: 1912); and *Kunsthistorischer Übersichtsplan von Wien*, Scale 1:25,000, (Vienna: 1915).

[33] R. Quenedey, "L'Habitation Urbaine et Son Evolution," *Annales d' Histoire Economique et Sociale*, Vol. 6, Nos. 25-26, 1934.

[34] J. B. Leighley, *The Towns of Mälardalen in Sweden: A Study in Urban Morphology* (University of California Publications in Geography, Vol. 3, No. 1, 1928), pp. 1-134; and *The Towns of Medieval Livonia* (University of California Publications in Geography, Vol. 6, No. 7, 1939), pp. 235-314.

[35] O. Schluter, "Uber den Grundriss der Städte," *Zeitschrift der Ges. f. Erdkunde zu Berlin*, Vol. 34, 1899, pp. 446-62, "Bemerkungen zue Siedlungskunde," *Geographische Zeitschrift*, Vol 5, 1899, pp. 65-84.

[36] E. J. Siedler, *Märkisher Städtebau im Mittelalter* (Berlin: 1914), with numerous plans.

[37] Fr. Meurer, *Die Mittelalterliche Stadtgrundriss im nördlichen Deutschland in seiner Entwicklung zur Regelmässigkeit*, 1914.

[38] A. Honig, *Deutscher Städtebau in Böhmen* (Prague: 1921).

[39] Chr. Klaiber, *Die Grundrissgestaltung der deutschen Stadt im Mittelalter unter besonderer Berücksichtigung der Schwäbischen lande*, (Berlin: 1921).

[40] P. J. Meier, *Niedersächsiecher Städteatlas, Die Braunschwiegischer Städte*, Abtilung I (1926) and II (1933), *Veröff. d. Hist. Kom. f. Niedersachsen.*

[41] See footnote 29.

[42] R. Martiny, "Grundrissgestaltung der Deutschen Siedlungen," *Petermanns Mitteilungen, Ergänzungsheft*, Nr. 197, 1928.

that have emerged by unplanned growth from village origins (*Haufendörfer*) that are characterized by complexity of plan (the type is rare in western and central Europe); the radial and wheel or radial-concentric plans that are usually the result of gradual growth from a nuclear market settlement; and axial plans that grow from a central axis, the main thoroughfare, to form rib, parallel-street and grid plans. The planned forms fall into five groups—the street market with or without a rib plan; the right-angled street crossing with the main streets directed to four gates in the town walls—a type that is frequent in southern Germany; the parallel-street plan with long main streets and long blocks separated by very narrow transverse streets; meridianal or spindle plans, a development from the last type in which the streets converge at two gate exits; and, lastly, the grid plan, with a right-angled net of streets of equal width with equal-sized blocks, and a central block in the center reserved for the market place (*Kolonialstadt*). The present writer has examined this whole field of literature in a recent essay.[43]

It is, of course, a short jump from such study of towns to comparative studies in architecture and art, since these are the visible expression of distinctive cultures. This is again a borderline study to which German and French scholars have given some attention. Mention may be made of the detailed study of the history of urbanism by P. Lavedan,[44] now director of the Institute of Urbanism in the University of Paris, and to the comparative studies of Glück, Gerstenberg, and Pieper.[45]

The foregoing comments and references are primarily concerned with the town in western and central Europe. There are, however, fundamental differences in the character of urban, as of rural, settlements in the neighboring culture areas of Europe, as also in the different culture areas and environments of the world, that still await detailed investigation on similar lines. There are some valuable and stimulating studies, both individual and comparative, of this kind. Mention may be made of Wilhelmy's detailed work on Sofia, that is interesting for both its method and matter, Whittlesey's Study of Kano as a Sudanese capital, H. de Martonne's essay on Buenos Aires, and Clerget's study of Cairo.[46] Among the comparative studies, the importance of which we wish to emphasize for future work, there are brief but suggestive studies by Andrews on the growth and pattern of settlements in the Riverina as characteristic of trends in the newly settled grasslands and, more recently, by Deffontaines on the network of towns in Brazil.[47] We have already suggested that in thinly peopled regions,

[43] Robert E. Dickinson, "The Morphology of the Medieval German Town," *Geographical Review*, Vol. 35, 1945, pp. 74-97.

[44] P. Lavedan, *Histoire de L'Urbanisme: Antiquiete et Moyen Age* (Paris: 1926), 352 plans and 32 photographs. Also by the same author *Qu'est-ce que l'Urbanisme? Introduction a l'Histoire de l'Urbanisme* (1926) and *Geographie des Villes* (1936).

[45] H. Glück-Wien, "Das Kunstgeographische Bild Europas am Ende des Mittelalters und die Grundlagen der Renaissance," *Monatshefte für Kunstwissenschaft*, ed. by G. Biermann, 1921, Band 2, pp. 161-73. K. Gerstenberg, *Ideen zu einer Kunstgeographie Europas* (Bibliothek der Kunstgeschichte, Band 48/9, 1922). P. Pieper, *Kunstgeographie: Versuch einer Grundlegung* (Neue Deutsche Forschungen, Abt. Kunstwissenschaft und Kunstgeschichte: 1936).

[46] H. Wilhelmy, *Hochbulgarien, II, Sofia, Wandlungen einer Grosstadt zwischen Orient und Okzident*, (Schriften des Geographischen Instituts der Universität Kiel, Band 5, 1936). H. de Martonne, "Buenos Aires," *Annales de Geographie*, Vol. 44, 1935, pp. 281-304. D. Whittlesey, "Kano: A Sudanese Capital," *Geographical Review*, Vol. 27, 1937, pp. 177-99. M. Clerget, *Le Caire, Etude de geographie urbaine et d'histoire Economique*, 2 vols. (Paris: 1934). See also as examples of recent studies O. H. K. Spate, "Rangoon: A Study in Urban Geography," *Geographical Review*, Vol. 32, 1942, pp. 56-73; C. M. Zierer, "Melbourne: A Functional Center," *Annals of the Association of American Geographers*, Vol. 31, 1941, pp. 251-88, and A. Wagner, *Werden, Leben und Gestalt der Zweimillionenstadt in Südkalifornien* (Schriften d. Geog. Instituts d. Univ. Kiel, Band 3, 1935).

[47] J. Andrews, "The Settlement Net and the Regional Factor," *Australian Geographer*, Vol. 2, 1933-5, pp. 33-48. P. Deffontaines, "The Origin and Growth of the Brazilian Network of Towns," *Geographical Review*, Vol. 28, 1938, pp. 377-99.

where there is not a continuous spread of human settlement and where civilization is backward, urban character is rudimentary and bears a close similarity to the conditions of western Europe in the Dark Ages; urban studies in such areas are of particular value on the question of urban beginnings in Western Europe. In this connection we would note, for example, the studies of W. Fogg on the tribal markets and towns of Morocco and Gourou's study of the Tonkin Delta.[48] Morphological studies are fewer, but mention maybe made of the essays edited by S. Passarge on cities in various regions (notably Spain, Japan, and China), and of the studies of the Moslem city, and of the cities of Japan and of the Netherlands East Indies.[49] Broader suggestive works are those of Jukerjee on the settlements of northern India, and Gutkind's recent essays on the city in Russia and China, both of which should stimulate further specific inquiry by geographers.[50]

Conclusion

With the ever-growing interest in the problems of the modern city—in the problems of its physical growth and reconstruction, in its sociological and economic structure, and in its art and architecture, as well as in its historical development—it is not surprising that there is a great deal of overlap between the approach from slightly different angles of different specialists in the same field. This is as it should and must be. It will be obvious, however, that the trained historian is best fitted to deal with the documentary evidence relevant to the formation of cities and that the art historian can best deal with individual and comparative studies of urban architecture. The geographer has introduced new fields of study in the structure of cities and it is likely that these will be taken up by other specialists. Indeed, for many years various specialists have shown an interest from their own points of view in the same phenomena.

This consideration is of very great importance in relation to a considerable field of social study which has been taken up in recent years especially in the United States. Since the last war a school of "human ecology" has developed with its seat in the Department of Sociology in the University of Chicago, under the leadership of R. E. Park, E. W. Burgess, and R. D. McKenzie. This school is distinct from that of the geographers in the same University, whose former chairman, Harlan Barrows, defined geography as human ecology in 1923. These sociologists claim that human ecology is the scientific study of the "spatial and temporal relations of human beings as affected by the selective, distributive, and accommodative forces of the environment," and one of its chief concerns is "the effect of position, in time and space, upon human institutions and human behavior."[51] This definition is vague, but a formidable research literature indicates its scope and the very valuable results it has achieved in the inter-war period. It is the equivalent of what the

[48] W. Fogg, "Villages, Tribal Markets and Towns: Some Considerations of Urban Development in the Spanish and International Zones of Morocco," *Sociological Review*, Vol. 32, Nos. 1 and 2, 1940; and "The Suq: A Study in the Human Geography of Morocco," *Scottish Geographical Magazine*, Vol. 51, No. 3, 1935. P. Gourou, *Les Paysans du Delta Tonkinois: Etude de Geographie Humaine* (Paris: Ecole Publique Francaise d'Extreme Orient, Vol. 27, 1936.)

[49] S. Passarge (ed.), *Stadtlandschaften der Erde* (1930). Busch-Zantner, "Zur Kenntniss der Osmannischen Stadt," *Geographische Zeitschrift*, Vol. 38, 1932. G. T. Trewartha, "Japanese Cities: Distribution and Morphology," *Geographical Review*, Vol. 24, 1934, pp. 404-17. H. Lehmann, "Das Antlitz der Stadt in Niederländisch-Indien," *Festschrift Norbert Krebs, Landerkundliche Forschung*, 1937.

[50] R. Mukerjee, *Man and His Habitation: A Study in Social Ecology* (1940); and E. A. Gutkind, *Revolution in Environment* (1946).

[51] R. D. McKenzie, "The Ecological Approach to the Study of the Urban Community." *The City*, by R. E. Park, E. W. Burgess, and R. D. McKenzie (Chicago: 1925). See also the comprehensive text book by N. P. Gist and L. A. Halbert, *Urban Society* (New York: 1941), especially chapters 6 and 7.

French sociologist calls "la morphologie sociale."[52] This field has two aspects, the spatial or geographical aspect, and the biological or demographic aspect. The former in particular, is common ground to geography, sociology, economics, and anthropology.

The social ecologist is concerned with Man in Society. He thinks in terms of social phenomena and social interactions in their distribution in time and space. Such interactions, by a process of competition and selection, are expressed in the physical and social mobility of persons, that is, in "change of residence, change of employment, or change of location of any utility or service."[53] The processes accounting for these distributions in urban growth are referred to by R. D. McKenzie as: concentration, centralization, decentralization, segregation, invasion, and succession. Immigrants tend to segregate in areas populated by persons with a similar background of culture and economic status—birds of a feather flock together. In consequence of this process, the city tends to become a sort of mosaic of "cultural and racial islands." Such islands are called by the social ecologists "natural areas," since they grow up by natural (uncontrolled) processes, and each area tends to select certain population types, this selection being based on economic status, racial characteristics, religious beliefs, moral codes, and the like. Thus, to the social ecologist "the natural area as a form of ecological patterning is primarily a social rather than a geographic phenomenon." In the American city at present language and customs are especially potent in the formation of natural areas but, as the immigrant is absorbed and his own language and customs disappear, "social differentiation will manifest itself in other ways—through differences in religion, occupation, education, and income."[54]

The geographer, as distinct from the social ecologist, is concerned with the differentiation of the whole of the urban settlement into its functional areas and social groupings as expressed in the structure and uses and grouping of its building structures. He does not limit his study to the measure of relationships of the settlement to its site and situation. His primary emphasis is on the settlement as a habitat. He is concerned with geographical distributions in the settlement in so far as they represent areal differences in function that are significant for other kinds of phenomena in the same area and for the same population group. The geographer has no established terminology for these component functional units. It is unfortunate that Blanchard refers to them as "natural" regions but he is using the word, in effect, to define, though with different emphasis, exactly the same thing as the "natural area" of the sociologist and the planner and economist, that is, as a unit in the urban complex that has emerged through the operation of processes of growth and differentiation.

Many sociological studies of the "natural areas" of American cities have appeared, but what is of most interest to the sociologist is the distribution of social maladjustment in disorganized areas—delinquency (adult and juvenile), vice, suicide, mental disorders, alcoholism, divorce and desertion, poverty, mortality, and disease. The areal inter-relationships of such phenomena also have been studied and indexes of social disorganization worked out. In H. W. Green's study of Cleveland, Ohio, for example, a

[52] M. Halbwachs, *Morphologie Sociale*, Collection Armand Colin (Paris: 1938).

[53] R. D. McKenzie, "The Scope of Human Ecology," in *The Urban Community*, edited by E. W. Burgess (Chicago: 1926).

[54] Quotations from Gist and Halbert, *op. cit.*, Chapters 6 and 7, *passim*.

map of cultural areas was prepared, based on the monthly rental figures, as indicating the economic status of the residents, and correlations of social phenomena were made with districts in low and high income categories.[55] The sociologists are also more concerned with, and better equipped for, the investigation of social groups in the city, such as "neighborhoods" and the larger "community areas," and here too the principal contributions have come during the inter-war period from the United States.

This whole field of study, geographical and ecological, has now become of great importance in Western Europe in view of the urgent need for reconstruction. The elaborate social and economic surveys in Britain have neglected this side of study, with a few exceptions such as the surveys of Merseyside, Southhampton, Sheffield, and the recent County of London Plan. Civic and regional surveys as preliminaries to town and inter-town planning have been dominated by the idea of the interrelations of Place, Work, and Folk, which embraces all relevant sciences on a footing of equality in a broad philosophical concept. But this approach fails to canalize and direct research to special problems of social structure in their geographical (or areal) aspects, which is essential for the sound, long-term, physical planning. Significant advances in concept and techniques have been made, however, during the past six years in Britain. We may mention the work sponsored by the Association for Planning and Regional Reconstruction, by the West Midland Group on Post-War Reconstruction and Planning, and by the Nuffield Reconstruction Survey at Oxford. In more direct connection with town planning there are the surveys of Hull and Middlesbrough organized by Max Loch, those of Durham and Exeter organized by Thomas Sharp, and the detailed study of Worcester, undertaken by a group of researchers in the University of Birmingham. There is need, however, for more research workers with adequate training, for the development of techniques of recording, classifying and mapping data, and for the standardization of terminology. There is no clear-cut line of division between one discipline and another, and the emergence of disciplines in the common pursuit of particular problems is a characteristic of the development of scientific research in our time. In the field of the study of Man, there is a real need for institutes of research to investigate all aspects of the problem, for without fundamental researches the planner cannot provide for the optimum use of the land, and the architect cannot build to suit the needs of Man, both as an individual and as a member of the community.

[55] H. W. Green, "Cultural Areas in the City of Cleveland," *American Journal of Sociology*, Vol. 38, 1932, pp. 356-67. See also Gist and Halbert, *op. cit.*, Chapter 9, "Disorganized Areas."

Tidal Power in Maine

By LINCOLN SMITH*

THE national shortage of electrical power has focused attention recently on the Passamaquoddy project at Eastport, Maine, where the 18-foot tides may be harnessed to generate between 500,000 and 700,000 horsepower in electrical energy. The present Smith Bill now before Congress asks for $100,000,000 to proceed with the development, and the matter has been referred to the International Joint (boundary) Commission for a survey and report. Although long rejected and dismissed as an impractical dream, implications that high government officials have revived interest in tidal power have encouraged Maine political leaders and Quoddy supporters.

Conceived originally by the late Dexter P. Cooper, well known engineer, as an international project requiring the cooperation of the United States and Canada, construction work on a modified plan and more modest scale was undertaken by the United States alone early in the first Roosevelt administration. Approximately $7,000,000 was spent by the Public Works Administration and Army engineers on the tidal power scheme, but work was abandoned after Congress failed to provide additional funds.

The occasion in 1947 which again brought Quoddy in the headlines was a controversy over the use of the 232-acre industrial and residential village. One plan was to give to displaced persons bound for South America technical training at a tractor assembly plant which would be established at the site. The other, sponsored by the United Lithuanian Relief Fund, was to transfer Baltic University from Hamburg, Germany, to Quoddy Village.

The White House was reported to have let it be known "that President Truman favors revival and completion of the Quoddy power project."[1] Governor Horace A. Hildreth of Maine stated last autumn that plans for the establishment of a gigantic laboratory for future scientific air development were under consideration, "with Maine definitely in the picture as a possible location."[2] He quoted General O'Donnell, director of information of the United States Air Forces, that "the plan is so gigantic that we will take a close look at every possible location."

Representative Margaret Chase Smith of Maine suggested to President Truman and the Secretaries of the Army and Navy that the Quoddy site be made either an international military base, an international power development, or both. In reply Secretary of the Navy James Forrestal said that Passamaquoddy "has not been considered heretofore for use as an international military base. However, all such areas will naturally be scrutinized with a view toward possible use for hemispheric defense in any studies in the future. This consideration applies, of course, to all such locations throughout the entire country and not exclusively to Passamaquoddy."[3]

Although attempts to revive Quoddy frequently are made before elections in Maine, perhaps more pressing and timely factors make this reconsideration of the scheme more significant. The need for more power and future prospects of shrinking oil and coal supplies are already matters of concern both to Canada and the United States. National and hemispheric defense, the fact that military

* Assistant Professor, Department of Political Science, University of California at Los Angeles.

[1] Portland *Press Herald*, Aug. 30, 1947.
[2] *Ibid.*, Sept. 6, 1947.
[3] *Ibid.*, Sept. 11, 1947.

and industrial uses strained the power capacity close to the breaking point in the last war, that atomic energy plants are heavy users of power, that peacetime industrial production is expanding, and that civilian use of electrical energy is increasing, makes it imperative that new power sources be obtained. Some people believe that the nation must have more power now, perhaps almost regardless of cost. Therefore, projects which were not feasible 12 or 15 years ago are now in line for development. This view recognizes that it might cost double to construct previously considered sites at the present time.

The attempts to revive Quoddy coincided with Maine's tragic forest fires, drought, and consequent power emergencies in the autumn of 1947. The power situation in the Aroostook area particularly was acute. In the emergency the Navy sent two destroyer escorts to Portland whence, by relay through the lines of cooperating companies, power was fed north into Aroostook.[4] While the drastic curtailment in the northern counties was termed "an act of God," according to the Maine Public Utilities Commission, steam generation is becoming of increasing importance each year. Hydro still provides about 80 per cent of Maine's power, but steam stations are in use all of the year except a few weeks in the spring and at times half of the total energy is produced by steam.[5]

The late Dexter P. Cooper originated the Passamaquoddy Tidal Power Project some 40 years ago while convalescing at the summer home of his wife at Campobello, where he saw the tremendous tides daily. He and the late Franklin D. Roosevelt, then Assistant Secretary of the Navy with a summer home at Campobello, are reported to have discussed the possibilities of a tidal power project. Mr. Roosevelt, while campaigning for Vice-President in 1920, first hinted in an Eastport address that plans were being formulated for such a project.[6]

Cooper's original international plan involved Passamaqoddy Bay located partly in Canada and Cobscook Bay wholly within the boundaries of the United States. The plan was to dam the high level pool so that it would always be nearly full of water, letting in at high tide all the water necessary. A second dam at the mouth of adjacent Cobscook Bay to prevent water from getting in would keep it always at a low level by draining it thoroughly at low tide. With Passamaquoddy always nearly full and Cobscook always low there would be a continuous water fall through turbines from the upper into the lower or receiving pool. By placing the two bays under mechanical control with the level of the upper pool higher than that of the lower, the upper pool would be filled every 12 hours and the lower pool drained every 12 hours. The difference in the level of the water in the two pools would give a normal fall or head of from 8 to 20 feet. In the area of about 100 square miles the tide rises and falls as much as 20 to 25 feet every 12 hours, and four times a day about two billion tons of water boil through the narrow passages at the mouth of the Bay.

Mr. Cooper estimated that the project would produce more than 600,000 H.P. which would run into billions and billions of KWH. The cost of the project was estimated at from $75,000,000 to $100,000,000,[7] and electricity could be produced there for three-quarters of a cent per KWH.[8] He believed that this money would be available from private

[4] Portland *Sunday Telegram*, Jan. 4, 1948.
[5] *Twelfth Biennial Report*, P.U.C. Maine, 1945-6, p. 18.
[6] Eastport *Sentinel* (feature article), March 16, 1938.
[7] Maine *Legislative Record*, 1925, pp. 975-6, 979.
[8] *Ibid.*, p. 981.

sources.[9] Other estimates were that over 20 billion KWH were theoretically available from the international project, but "practical considerations" would limit it to three billion KWH or nearly 500,000 H.P. each year.[10]

Senator Charles B. Carter opposed the Cooper project in the Maine Senate in 1925, calling it a vision and a phantom existing only in the imagination of one man.[11] He also expressed doubts as to its engineering feasibility. His greatest objection was to a provision in the charter enabling the corporation to transmit surplus power to other states. Since 1909 it has been a cardinal principle of Maine power policy to prevent the transmission of power outside the state.

Senator Hinckley undoubtedly expressed the opinion of many Maine people when he said:[12] "Why not give him [Cooper] a chance to try it? What objection is there?" The charter was passed in the Legislature in 1925 subject to popular referendum. Except for Washington County where the project was to be located, relatively few votes were cast; the Cooper charter passed 53,000 to 7,000.

In 1926 the New Brunswick Legislature also gave Cooper a charter which stipulated that active construction must be started within three years and the project completed by 1932. Three years later the Dominion Parliament rejected Cooper's petition for an extension of the charter because of opposition by fisheries interests and the Canadian Pacific Railroad.[13]

Later Cooper filed a revised application, the All-American plan, for a two-pool project entirely within the United States and with initial and ultimate installations of 80,000 and 240,000 H.P., and contemplating the eventual construction of a pumped-storage plant at Haycock Harbor, 12 miles away, as an auxiliary to the tidal power plant.[14]

While still referred to as the Passamaquoddy development this two-pool American plan was confined to Cobscook Bay of the United States. This project was generally considered as merely the initial step in the consummation of the international project. Inasmuch as the major installations would be on the American side the smaller project involved about two-thirds the cost for about half the power to be expected from the larger. For this reason the All-American project was vulnerable to attack on the score of power cost. But, on the other hand, it was not intended to function permanently as an independent power-producing unit. Many of its proponents believed that if it were built the Canadians would be induced to grant a charter and that with little expense the two-pool American project could be incorporated into the international Quoddy project. Yet it was difficult to explain the long-range plan.

Quoddy is an example of a project planned by private capital and supported by pressure groups, but which could not be financed without public aid. When

[9] *Ibid.*, p. 979.

[10] *Principles and Facts Underlying Quoddy Tidal Power Project.* Pamphlet issued by the Eastport District, U. S. Engineer Office. Republished by Shead Memorial High School, Eastport, Maine. (no date) p. 3.

[11] Maine *Legislative Record*, 1925, pp. 976, 978.

[12] *Ibid.*, p. 979.

[13] It was claimed that the construction of the project would greatly reduce the sardine, clam, cod and haddock fisheries in Passamaquoddy Bay and along the coast of Charlotte County. See A. G. Huntsman, *The Passamaquoddy Bay Power Project and Its Effect on the Fisheries.* Atlantic Biological Station, St. Andrews, N. B. (c. 1928), pp. 44-5. Early in 1930 President Hoover announced the allocation of $45,000 as our country's share in a joint investigation by the United States and Canada of the effect of dams on the fisheries in the area, and after four years of investigation an international commission reported that it would hurt the fishing business. The railroad opposition was based on the contention that the project would ruin the resort business of the locality. See Ernest R. Abrams, *Power in Transition* (New York: 1940), p. 262.

[14] *Passamaquoddy Tidal Power Project.* Senate Document 41. 77th Congress. First Session. April 7, 1941. pp. 2-3.

the PWA program was seeking relief projects Quoddy supporters immediately put up their plan. Cooper applied to PWA for a loan of $43,000,000 with which to construct the project.

PWA asked the Federal Power Commission for a report on the project. The Commission reported in January 1934 that the plan was unsound and unjustified because: (1) it would cost approximately $40,000,000 while a comparable steam-generating plant would cost only $16,000,000; (2) the steam-electric power would be cheaper at the higher-load factors; (3) Passamaquoddy power could not compete with steam power rates in export; and (4) there was then no market or prospective market for Passamaqoddy power at any price.[15]

After its rejection by PWA, Quoddy supporters decided to try to make it a federal project, to be built by the War Department and operated by an Authority created by the Maine Legislature. Quoddy was to be a project of "social value," the "salvation of an economic area."

Congressman J. G. Utterback of Maine released a letter from President Roosevelt assuring Utterback of Roosevelt's interest in Quoddy from its earliest days, and of his belief in its engineering practicability. Said the President:

"The principal stumbling block to a Federal appropriation . . . is that there is no definite assurance for the use of the power when developed. I am not suggesting that the full power development should be contracted for in advance but in other Federal projects we have had reasonable and definite assurance that the bulk of the power could be sold and a large portion of the receipts applied to the interest and amortization of the actual cost of construction. I think it is very decidedly possible for the good people of Maine to undertake to get a definite distribution use for the power when it is developed."[16]

Governor Louis J. Brann in the summer of 1934 announced President Roosevelt's request for the appointment of a committee of Maine citizens to study possible uses for Quoddy power. His letter said in part:[17]

"With my summer home so near Eastport, for so many years, I have been interested in what is known as the 'quoddy project' for a long time, and it has been my hope that eventually the State of Maine would become not only a great industrial center of the nation but that its agricultural population would be among the first to enjoy the manifest advantages of cheap electrical power on the farm as well."

The President then stated that a study ought to be made of the ways in which this power might be put to work in the shortest possible time; and that government funds were available for such public works projects if it should be found that the creation of the power were (1) practical and economical, and (2) could be made available for various definite uses and would not lie idle for many years.

Governor Brann named a committee of five to make the study, headed by President Kenneth C. M. Sills of Bowdoin College. Secretary of the Interior Ickes visited the scene, and appointed a Quoddy Commission to investigate. Largely on the basis of the latter, the so-called "Hunt Report," the Administration decided to construct Quoddy on its "social value," as a federal project, by War Department Engineers. The report, however, was kept in the deepest secrecy, and the PWA persistently refused to give it to reporters or to members of Congress[18]

The PWA special commission sub-

[15] *Ibid.*, p. 1.

[16] Portland *Press Herald*, July 16, 1934.

[17] Letter dated at the White House, Washington, D. C., July 1, 1934. Published in the Fort Fairfield *Review*, July 25, 1934.

[18] Elizabeth M. Craig, in Portland *Press Herald*, March 8, 1935.

mitted a favorable report to the Administration, recommending that $30,000,000 be alloted to the War Department to finance the construction, and that a state power authority be created to lease and operate the project. The recommendation was for the construction of an "immediate project consisting of a single basin, tidal power installation, utilizing Cobscook Bay; a power storage plant near Haycock Harbor; and a 16-mile electric transmission line connecting the two," at an estimated cost of $30,125,000; and stated that the ultimate plan as contemplated would consist of an international project.[19]

The single-pool All-American plan, smaller and less expensive than either the international or two-pool All-American projects, called for the construction of a dam across the mouth of Cobscook Bay similar to Cooper's original plan. But the contemplated two-mile dam across Cobscook Bay to provide both an upper and lower pool within the bay was omitted.[20] This would have meant less control of the water flow, with the use of all of Cobscook Bay as the lower pool and the ocean as the upper pool.

The unanimous conclusions of the committee headed by President Sills were first, that the Quoddy project could be constructed at this time only as a federal project; and second, as a federal project it should be undertaken at once and carried to completion as promptly as efficiency in construction would permit.[21] The committee felt that the project came properly under a program of public works because it undoubtedly would employ for many months a large number of people on the relief rolls, and it would bring lasting benefit to the state. The committee argued for federal support of the project largely on the grounds of "social desirability," that is, of benefit in the long run and in many ways without definite assurance that the project would be within a specified number of years self-liquidating. It was pointed out that in the depression era no private capital was available for the project and that the government had denied a loan to a private corporation because a sufficiently certain market for the power was not shown. The state of Maine could not finance Quoddy even if it so desired because for constitutional reasons, it could not borrow such a large sum of money. The committee pointed out numerous possibilities for the sale of the power, and stated that many Maine people felt that the state should receive a share of the money available for such projects.

In March 1935 the relief bill in which Quoddy funds were included, was passed by Congress, and two months later PWA formally recommended allocation of $10,000,000 to Quoddy. President Roosevelt and Comptroller-General McCarl promptly approved the initial allocation.

Construction work was assigned to the Army engineers; not because the project was connected with war or national defense, but because the Army Engineer Corps traditionally has been the engineering department of the national government.

The Army engineers went ahead with the single-pool project but experimented with the idea of departing radically from the Cooper plan by making Quoddy the low tide-level pool and keeping Cobscook full of water at all times. Supporters of the Cooper plan believed that this revision would have spoiled the whole long-range plan by creating a condition strongly militating against, if not defi-

[19] S.D. 41, *op. cit.*, p. 4.

[20] Portland *Press Herald*,, May 18, 1935.

[21] *Report on Passamaquoddy Tidal Power Project* by the Quoddy Hydro-Electric Commission. Unpublished manuscript, Jan., 1935. p. 2. (One of the few available copies of this document is located in the Bowdoin College Library, Brunswick, Maine.)

nitely putting an end to, hope for the ultimate co-operation of Canada.

In late October half of the original Quoddy allocation was taken away and early the next year a general layoff of labor started. President Roosevelt restored $2,000,000 of the allocation about three months later, after appeals from local residents and recommendations by the Army engineers.[22]

When President Roosevelt submitted his budget in January 1936 he recommended to Congress that 29 million dollars be given to the rivers and harbors section of the War Department Bill for Quoddy, the Florida ship canal, and three small projects. The President said at a press conference that, unless Congress gave him authority for Quoddy, he would not give the project any more money from work relief funds.[23] He did not and Congress refused this authority.

During the campaign in the summer of 1936, President Roosevelt speaking from his cottage porch on Campobello Island, told 700 Washington County folk Quoddy would be completed. First, however, he said the rest of America—where Quoddy is not well understood—would have to be "educated" to an appreciation of its possibilities. At an afternoon press conference he called Quoddy a "laboratory" for what might in time become a great hydro-electric development by the United States and Canada.[24]

In 1939 President Roosevelt asked for a revival of Quoddy. He said:

"Money has been spent at the Passamaquoddy Bay tidal power project. It is my belief that the time will come when there will be a joint agreement between Canada and the United States for joint development of the larger project which would utilize all tidal power in that bay on both sides of the international line. It is a fact that in Eastern Maine the economic situation is, today, at its worst—for the forests have been cut off and the fisheries have greatly declined. In the case of this project, existing surveys are insufficient and it is my thought that an appropriation for the completion of test borings and a determination of the advisability of putting in a small experimental plant on the American side of the border would be justified."[25]

The Federal Power Commission was asked to review its previous reports on the project, to bring them down to date, and to report to the Senate on the relative costs of power to the consumer, and again on the vital question of markets for power.[26] The Commission's report to the Senate was unfavorable to the immediate construction of the All-American tidal power project.

This report showed a need for additional hydroelectric power in Maine, New Hampshire, Vermont, and central and eastern Massachusetts. Quoddy power was rejected, however, because less expensive power could be developed on the Maine rivers.[27] The Commission suggested a tentative plan for the coordinated development of 17 power sites on Maine rivers estimated to produce 2,444,000,000 KWH annual output. The unit cost of the energy per KWH at that time was estimated at 1.87 mills on the basis of federal or state financing. On the basis of private financing with interest at five per cent and the payment of taxes the estimate was 3.26 mills per KWH. The Commission estimated that power from the two-pool All-American Quoddy project would cost from 6.65 to 10.47 mills per KWH, depending upon rate of interest on the capital investment, taxes, and insurance.

Two years later Senator Wallace H. White, Jr., asked President Roosevelt to take up the international project with Canadian authorities. The President felt that for the war effort both countries

[22] Eastport *Sentinel*, Jan. 15, 1936.
[23] Portland *Press Herald*, April 4, 1936.
[24] *Ibid.*, July 30, 1936.
[25] *Ibid.*, Jan. 18, 1939.
[26] Senate Resolution 62. Adopted Feb. 2, 1939.
[27] S.D. No. 41, *op. cit.*, pp. 14, 19-23.

should look to projects more thoroughly investigated; also the location of a power project on the sea coast raised serious questions from a military point of view.[28]

Why Quoddy Was Not Completed

One of the major questions on the Quoddy project, and one never satisfactorily answered, was what would be done with the tidal power if the project were completed. One suggested outlet was to transmit Quoddy power by radio for consumption in distant cities![29] Governor Louis J. Brann in his contest for United States Senator in an Eastport address suggested that inasmuch as Eastport is the nearest United States port to Europe, the completion of the project would pave the way for the establishment of the largest naval base in the world.[30]

After the War Department purchased the rights, titles, franchises, engineering plans and privileges of Dexter P. Cooper, Inc., for $60,000, Mr. Cooper became an advisor to the government on the project.[31] He was charged specifically with finding a market for the electricity Quoddy would generate[32] and given $25,000 and a year's time to make a comprehensive study.[33]

Several times Mr. Cooper reiterated the statement that he had arranged sale of "all the power Quoddy could produce under the present plans."[34] It was implied that the sale was to concerns of national standing which would locate factories at or near Eastport and which would create employment for at least 2,000 people. It was also stated that the signatures of final sale would have to await the establishment of a Quoddy Authority competent to sign them and the determination of the date at which the power would be available.[35]

Senator Vandenberg showed a great interest whether markets existed for Quoddy power at a Senate committee hearing in May 1936. Senator White, Governor Brann, and Representative Brewster repeated in response to his questions that Cooper insisted there was a market for the power although he had not disclosed it. In response to Senator Vandenberg's question whether Cooper would be willing to testify before the committee to that effect, Representative Brewster replied Quoddy power was in competition with that of Canada and that of western projects and to divulge these markets publicly might mean their loss.[36]

Most of the results of Mr. Cooper's study were in his head; and he died without putting them on paper. "There was a Cooper report which was never divulged and rumors of a still more secret report, with names and places and amounts of market but this is one of those Washington mysteries."[37]

State Senator Clarence B. Beckett of Calais, a member of the Washington County Chamber of Commerce Committee on Quoddy, stated his conviction that Cooper had arranged for industrial use of every bit of power Quoddy could produce but he "was unable to publish the list of those industries for fear of embarrassing them in the communities where they are now located."[38]

It was unfortunate for Quoddy that no specific facts were ever publicly given to

[28] Portland *Press Herald*, April 4, 1942.
[29] *Ibid.*, Feb. 15, 1936.
[30] *Ibid.*, Aug. 13, 1936.
[31] *Ibid.*, Oct. 29, 1935.
[32] Lewiston *Daily Sun*, March 6, 1936.
[33] Portland *Press Herald*, Jan. 18, 1939.
[34] Lewiston *Daily Sun*, March 6, 1936; Eastport *Sentinel*, March 11, 1936; Portland *Press Herald*, Aug. 13, 1936. This announcement first came when the project's financial future was before Congress. Federal Power Commission estimates of the output of the single-pool project varied from 175,000-000 to 340,000,000 KWH, depending upon the number of generating units installed. See S.D. 41, *op. cit.*, p. 15.
[35] Eastport *Sentinel*, March 11, 1936.
[36] Florida-Ship Canal and Passamaquoddy Tidal Power Projects." Hearing before the Committee on Commerce. U. S. Senate. 74th Congress, Second Session, on S.J. Res. 266. Part I. May 20, 1936. pp. 4-11.
[37] Portland *Press Herald*, Jan. 18, 1939.
[38] *Ibid.*, Feb. 1, 1939.

support the contention that there was a market for most of the power. Senator Vandenberg and other opponents of the project made much of this. On the other hand, it should be brought out that very few if any industries could prudently contract with Quoddy for power when there was so much uncertainty if and when power would be available from the project.

The reports of the Maine Quoddy Commission and Maine State Planning Board on possible markets for Quoddy power were likewise, of necessity, indefinite. Attention was called to the fact that electric power would not be available for over two and a half years and that industrial plants could probably be constructed and ready for operation within six months after the completion of plans and selection of equipment. "Accordingly, it is difficult to anticipate the improvements that may be made in the manufacture of products, now assumed, or the markets for them two or three years hence and we can only base our information in the present and past operations."[39]

As possible markets for this power the Board pointed to the limited supply available in Aroostook County and in southeastern Maine, a demand for power at reasonable rates by the present electric utilities, many communities without service, and the paper mill at Woodland. With a high tension transmission line about 110 miles from Quoddy to Houlton, interconnecting with the lines of the Maine Public Service Company and furnishing power at low cost, a possibility was seen of a market of 20 to 30 million KWH in the near future. Another suggested source of market was the electrification of railroads.[40]

The Commission pointed out that while many of the large power developments have been undertaken without a definite power market in sight, there was a reasonable possibility of attracting several new major industries to eastern Maine which would not come without the construction of Quoddy.[41]

The suggestion also was made by the Board that in a development of this magnitude it might be wise to develop several smaller industries distributed among outlying communities, the current consumption of each of which would be comparatively small but in the aggregate amount to considerable.

A survey of raw materials locally available for manufacturing indicated that feldspar and clay were the most important, although others exist in large quantities. The construction of plants which require much power in the manufacturing process was considered, particularly aluminum, stainless steel, nitrogen fixation, and other metallurgical and industrial plants. The need for synthetic rubber was not great when the report was made, but might well be considered. This, like aluminum, requires much processing and consequently great quantities of power. It is light in weight and the transportation costs would be small despite the distance between Maine and the market centers.

The Board pointed to the growth of Maine's industrial cities of a century ago, resulting from cheap power, inferring that a supply at Eastport in 1936 would be sufficient to induce industries to locate there. Unfortunately, however, the report did not give sufficient attention to the relative importance of power as compared with other factors in determining the location of industry. Its thesis was that cheap power would attract industries requiring large amounts of it

[39] *Report on Passamaquoddy Tidal Power Project* by the Quoddy Hydro-Electric Commission, *op. cit.*, pp. 3-4; *Report on Passamaquoddy Tidal Power Project* by the Maine State Planning Board. p. 159.

[40] State Planning Board Report, *supra.*, pp. 159-60.

[41] Quoddy Hydro-Electric Commission Report, *op. cit.*, p. 4; Maine State Planning Board Report, *op. cit.*, p. 159.

and having low transportation costs because of light products.

A century ago, when power costs were high and labor costs relatively low, the presence of power attracted industries to its site. Now, however, high labor and transportation costs have reduced the relative importance of power, and technology now enables power to be transmitted long distances to industry. The geographical position of Maine in the extreme northeastern corner of the country puts it at a disadvantage for proximity to markets, but this will not necessarily hold for a few industries where the power factor is still dominant. These industries will locate near power if that power is cheap. It was claimed, however, that Quoddy power would be too expensive to attract industry.

The Maine State Planning Board pointed out that the Eastport region is one of the most beautiful portions of the Maine coast, very close to the summer home of President Roosevelt, who was quoted as having felt that it had very high possibilities for recreational development.[42] The area has many recreational facilities, the coolest summers in the state, and is also free from hay fever. If properly advertised, not only could thousands of hay-fever sufferers be attracted to the region, but its recreational development should net $10,000,000 annually in 10 years. It was estimated that this new industry would use $300,000 worth of electricity annually.

Consideration was given also to the fact that Eastport has one of the best harbors on the Atlantic Coast, 283 miles nearer Gibraltar and 425 miles nearer Liverpool than is New York City. It is ice-free throughout the year, and during the exceptionally cold weather it is one of the few harbors on the North Atlantic Coast not closed by ice troubles.[43]

In 1941 another study of possible markets for Quoddy power was made by the Bureau of Engineering of the Federal Power Commission in response to U. S. Senate Resolution 62, Seventy-sixth Congress, first session, adopted on February 2, 1939, largely through the efforts of Senator Vandenberg.[44] The report clearly showed a need for more hydro-electric power both in Maine and nearby states. The idea of Quoddy power filling outside needs was rejected because it would be too expensive to be sold in Massachusetts. The other finding, the one which more than any other doomed Quoddy at the time, was that additional hydro-electric developments could be made more cheaply and economically on the Maine rivers than at Quoddy.

The report concluded:[45] "It seems obvious that, with knowledge of the high cost of producing tidal power at Passamaquoddy, responsible interests would not seriously consider locating an industry for the production of aluminum at or near Eastport, Maine, with a view to using such power." The report stated that electro-metallurgical and electro-chemical industries requiring large amounts of low-cost power might be attracted to the area on the Penobscot River below Bangor, where they could take advantage of cheap river hydro-electric power, and where they could be reached by ocean-going vessels.

Unless the international development materializes it would be sounder economics and politics to concentrate attention on the cheaper river developments. One of the newspapers editorially calls Quoddy a "hot" political question, resulting in "a disposition on the part of the candidates to talk more and more in

[42] Maine State Planning Board Report, *op. cit.*, pp. 241-55.

[43] The facilities of the area and its proximity to Europe were factors advanced by John A. Poor in his railroad plans for Maine and the European and North American Railroad almost a century ago.

[44] S.D. 41, *op. cit.*

[45] *Ibid.*, p. 35.

evasive broad terms and less and less in terms of specific proposals."[46]

Political Aspects—Why Maine Wanted Quoddy

Governor Louis J. Brann, Democrat and anti-New Dealer, successfully campaigned for re-election in 1934 and became Maine's first two-term Democratic governor since the Civil War on a platform calling for the establishment of the Quoddy project which would "bring some fifty million dollars into the State, to be expended in a section where it is as much needed as anywhere."[47] The Republican governors, Barrows, Sewall, and Hildreth, likewise expressed their interest in seeing the project completed.

There was considerable speculation in Maine as to the political motives behind the Quoddy project. President Roosevelt mentioned the development in his 1920 campaign for Vice-President, and it was revived in the midst of the state campaigns of 1934 and 1936. F. Harold Dubord, Democratic candidate for United States Senator, came out in favor of Quoddy, and Secretary Ickes made a timely visit to Maine, inspected and revived the project, but denied any political tinge to the Administration's attitude towards it.

Representative Ralph O. Brewster claimed that Thomas Corcoran (R. F. C. Attorney) threatened to hold up the Quoddy project if Brewster voted against the holding company "death sentence" as desired by President Roosevelt.[48] At the House of Representatives investigation Corcoran denied the charge, claiming that he had no power to stop the Quoddy project.[49] While it is impossible to ascertain precisely what was said, from the evidence it appears that Corcoran was zealous for Brewster to vote with the Administration on the holding company act and that he at least inferred that if Brewster voted against the act it would have some effect on Quoddy, or at least remove Brewster from all legal or representative connection with the project.[50]

Some of the political motives as alleged editorially by the Portland *Press Herald* were:

> "The Quoddy project was originally conceived by the President and his advisors in the hope of influencing the voters of Maine to support the New Deal. He evidently believed that the State of Maine could be bribed. When he found that the people of this State could not be bought, he simply tossed Quoddy on the scrap heap so that he could have the millions to use where they would produce more satisfactory results."[51]

It is seldom appropriate to attribute to individuals motives which guide their actions. Undoubtedly there were political motives behind the Quoddy project—for it and against it—yet the project was more than a political football. Before the 1936 and 1940 elections the Administration made gestures toward giving Maine the Quoddy project. To what extent these gestures were motivated by politics is impossible to discover. On the other side, the staunch opposition to this and other Administration projects by Senator Vandenberg undoubtedly had political tinges to them. Governor Brann tried to wrest the United States senatorship from Wallace H. White, Jr., partly with a contention that he and the Republicans in the Maine delegation at Washington had managed the Quoddy campaign poorly.

The Democrats actively supported the project in Maine, but the Republicans as a party did not. While the Democrats incorporated a Quoddy plank in their platform, the Republicans refused to do

[46] The Brunswick *Record*, May, 20, 1948.
[47] Ernest R. Abrams, *op. cit.*, p. 263.
[48] Lewiston *Evening Journal*, July 9, 1935.
[49] *Ibid.*, July 10, 1935.
[50] *Ibid.*, Sept. 12, 1935.
[51] June 1, 1936.

so. However, the Maine Senators, Congressmen, Governors, and many members of the state legislature gave their support to the project. Some frankly considered it "pork barrel" legislation and felt that Maine should come in for its share.

President Roosevelt, regardless of his political aspirations in Maine, unquestionably had a personal interest in the project, especially as an international undertaking. Although he could have completed it with relief funds had he so desired, on this occasion he insisted upon the sanction of Congress. It is also difficult to determine whether his suggestion for a small experimental plant there in 1939 was motivated by political aspirations in Maine, or a desire to see a concept which had interested him from its origin materialize as an experiment. By 1939 it must have been clear to the President and the Democratic political strategists that Quoddy was not a vote-getter outside of Washington County.

It would, of course, be an unwarranted oversimplification to conclude that the Quoddy proposals were merely part of a move to build up party strength. That was important, but by no means exclusive. There is always the necessity of determining whether a public works proposal should be undertaken, and under what conditions through the process of policy making which at some point in the democratic process includes ultimate popular consent. With its manifold activities, Congress is forced to seek guidance from special sources—independent regulatory commissions, investigatory commissions, President's staff agencies, and political and pressure groups; or grant wide discretionary powers to administration agencies.

To date, the commissions which have studied Quoddy have given either unfavorable reports or only mildly enthusiastic recommendations on it. The Federal Power Commission consistently has been opposed to the All-American project (the only one it has investigated) on the basis of economic infeasibility; the investigatory commission in Maine and some of the newspapers and political leaders have stressed the pork barrel aspects. Congress was interested in the former but was unimpressed with the latter. Probably the most favorable report was the Hunt Report which recommended Quoddy because of its social value. Regardless of the validity of the charge that this was a "packed" committee, note should be made that it was a report to an administrative agency, not to Congress. Although Congress appropriated the relief money, it was, nevertheless, largely on the basis of administrative action that construction work at Quoddy was started and stopped. President Roosevelt's personal interest in the project gave it a boost in the administrative stage. He even recommended to Congress that money be appropriated for its construction, but he was unwilling for Quoddy to be continued on the basis of administrative discretion.

At the start Quoddy fitted into the relief picture admirably. When the Administration was looking for relief projects and was showing interest in power development, it was to be expected that the pressure group with a ready plan would get a hearing. To be sure, the merit of the project was not thoroughly investigated, but it had possibilities in economic, social, and experimental values. With no other plans available to solve the acute relief problem in the area and the cheapest form of relief— the dole—generally unacceptable, it was logical for those ready with a plan to be given a chance. It could be started as a relief project, and in the meantime be given an opportunity to prove its economic worth. If its friends could show cause for its construction be-

yond the relief stages, then it should be for Congress to authorize its completion.

There was some opposition to the Quoddy project in Maine. It was a New Deal, Democratic measure, frequently revived in Maine before elections. It was sometimes attacked for political reasons, sometimes because of skepticism, and probably more often because of a belief that there was no market for the power at that time.

Many of its staunchest adherents believed its completion meant the influx of capital in a needy area. They were organized into a vociferous pressure group, and eventually won over to their side a large number of skeptics—people who doubted the economic validity of the project but who felt that Maine should obtain its share of the grants from the Administration in Washington. That Maine should get its share of the spoils was the main contention of the Maine Quoddy Commission:

"Your Commission, however, desires to base its main contention on the fact that the Quoddy project would be of great benefit to the people of the state of Maine. Maine people have always been independent, hard-working, frugal, self-reliant; their philosophy is based on the idea that every man should produce the wealth of which he was capable by industry and ingenuity; that he should live frugally and keep out of debt; that he should be self-supporting and independent. That attitude still prevails; but the people of Maine realize that conditions in the economic world have greatly changed and that Maine alone cannot prosper cut off from the central energizing power of the government. Maine has always been in the eddy of the national stream little affected by the tides of adversity and prosperity until the past few years. Since 1929 Maine has been watching other parts of the country receive very large sums from the federal government for flood control, irrigation control, power projects, and other purposes in the West and South. Today, perhaps with typical Yankee shrewdness, Maine feels that it is about time that she receive a modest portion of the vast sums that seem to be available, to be expended within her borders on a project that the majority of the people of the State believe will give great renewal to the industrial and agricultural life of Maine and will rehabilitate one of the most hard hit regions of the whole country."[52]

Quoddy's Future

The conclusions of the Federal Power Commission and the future possibilities of Quoddy were stated thus:

"Passamaquoddy tidal power cannot compete successfully at this time with river hydro-electric power potentially available in the State of Maine, or with power from modern, efficient steam-electric plants.

"Tidal power, while not economically feasible of development at this time, possesses certain distinct advantages over other sources of power, the water supply being thoroughly dependable and always definitely predictable, with head limitations definitely known. Unaffected by droughts, floods, or ice jams, the tides provide the most dependable and most permanent known source of power. As high-grade fuel prices increase concurrently with expanding power markets in the northeastern states and contiguous Canadian territory, the development of tidal power will, at some time in the future, become economically feasible and desirable.

"The fact that the development and utilization of tidal power is contraindicated at this time should not preclude thorough exploration of the possibilities of a large international tidal power project at Passamaquoddy by the Governments of the United States and Canada.

"The undeveloped water powers of Maine are clearly indicated as the source within that State from which large blocks of additional power should be obtained, as needed, in the immediate future. The cost of steam-electric power does not compare favorably with the estimated cost of power obtainable from the more desirable and undeveloped water-power sites in the basins of the Penobscot and Kennebec Rivers."[53]

The conclusion that additional power for the immediate needs of Maine could be more cheaply obtained from the rivers than from the All-American Quoddy

[52] *Op. cit.*, p. 5.

[53] *op. cit.*, p. 37.

project was unanswerable at that time. The potential value of the All-American Quoddy project in the future may depend upon two additional factors not yet considered. One is the importance of *saving* fuel in the future, and the other a possible need for relief projects in Maine.

After the development of cheap power on the rivers in Maine, there might be a need for Quoddy power in the Massachusetts area now so largely supplied by steam. Not only the cost factor of coal and oil, but perhaps the need for conserving these resources for other purposes would be paramount. If so, the development of Quoddy power and its transmission to those areas would be more than a matter of cost.

When it is suggested that the cost of the Quoddy project may be of secondary importance in the future, this assumes another scheme of values in which the present financial expense is less than other expenses and values which would be involved if the work were not undertaken. It would be wise to consider Quoddy in its proper perspective—as part of a state or regional natural resources policy. The Natural Resources Committee, for example, has indicated that each source of energy affects the others.[54] They are interdependent variables, and a policy for any one energy resource will affect its relative position with the others. In a war economy, particularly, it becomes necessary to save coal and oil for more specialized purposes. Hence expensive hydro or even tidal power might be justified for a long-range defense program. Relief aspects, likewise, might be involved.

The extent to which expensive power projects can be justified on the basis of relief is largely a matter of opinion. Sometimes, however, projects which ordinarily would be uneconomical become justified as work relief projects because the country would be better off with the development and jobs than with unemployment and its demoralization. Bauer and Gold concluded that if a project can be developed completely and produce power at six mills or less per KWH, it may be regarded as a financially justified undertaking.[55] Beyond six mills it becomes dubious except under special circumstances. The two-pool All-American Quoddy project under federal or state financing was estimated to provide power at 6.65 mills per KWH which would put it just beyond the limit of justified projects on this standard. The authors suggested, however, that no hard and fast rules can be laid down. The importance of hydro-electric power in the economy of Maine and New England in the future will determine what marginal projects are necessary. If the recent drought conditions should continue with intermittent regularity, hydro-electric power developed on the Maine rivers might be so unreliable that resort will be necessary to the most dependable and most permanent source of power known—tidal power.

Despite the lack of sufficiently reliable data at present to ascertain with any degree of accuracy the cost per unit of power on an international tidal power project, both President Roosevelt and Dexter P. Cooper claimed that this would produce much low-cost energy. Col. Fleming estimated the international project could produce power at two mills per KWH.[56]

A report that the New Brunswick fishing industries have declined in recent years was interpreted by State Senator Clarence B. Beckett to mean that opposi-

[54] *Our Energy Resources*, National Resources Committee (Washington: 1939). p. 30.

[55] John Bauer and Nathaniel Gold, *The Electric Power Industry* (New York: 1939), p. 38.

[56] Eastport *Sentinel*, March 16, 1938.

tion to Quoddy by fishing interests would probably be withdrawn if a treaty between the United States and the Dominion of Canada were broached.[57] Whether or not this might be done as part of a greater St. Lawrence project, or whether or not both countries would hesitate to invest in a huge project at such a vulnerable spot as Passamaquoddy Bay in time of war is unpredictable.

Quoddy's future depends upon its ability to produce power more cheaply than potential developments on the Maine rivers; unless, of course, national defense, conservation, and relief should necessitate government subsidy for non-liquidating power projects. It is agreed that Maine and New England need more power, and that pork barrel legislation is not conducive to wise national policy. Then are strong assertions that the United States and Canada jointly can produce very cheap power under Cooper's international plan. Since the Federal Power Commission's report labelled the All-American plan marginal, the next step in Quoddy's history will depend upon the outcome of further study by the two governments through the International Joint Commission[58] as to the international project's economic feasibility and political desirability. Such information is imperative. The conditioning factors are so dynamic that they may be modified in the years to come.

[57] Portland *Press Herald*, Feb. 1, 1939.

[58] The International Joint Commission has jurisdiction over territorial waters and other matters between the United States and Canada. Its administrative jurisdiction is well analyzed in C. J. Chacko, *The International Joint Commission Between the United States of America and the Dominion of Canada.* (New York: 1932). There is a valuable but uncritical chronology of Quoddy by C. Frank Keyser, Legislative Reference Service, Library of Congress, May 10, 1948. The Quoddy bill, H.R. 5821, was introduced by Mrs. Smith of Maine on March 11, 1948. It is expected that a revised measure will be submitted in January 1949. Portland *Press Herald*, July 7, 1948.

The Case for the Common Carrier in Trucking†

By WILLIAM A. SPURR*

CONTRACT motor carriers handle as much or more of the nation's inter-city freight than do common carriers. This, surprising as it is, apparently is due in part to the ease of obtaining permits, as compared with certificates, and the operating advantages that contract carriers enjoy over common carriers in being less stringently regulated by law. Yet it would seem better public policy for regulatory commissions to encourage common carriers since, like the railroads, they serve the whole public on regular schedules, at fixed rates, and are subject to closer control by law. Common carriers may be encouraged by issuing certificates of public convenience and necessity more readily where needed, or by regulating contract carriers more in line with common carriers, such as in the issuance of permits, rate regulations, requirements for insurance bonds, fees, and taxes.

In order to evaluate the functions of the common carrier in trucking, this study compares the merits of common and contract trucking and rail service in meeting the growing need for freight transport service, and forecasts these needs over the next twelve years. It begins with the basic criteria that determine the issuance of certificates of public convenience and necessity by public utility commissions, since these criteria cover the principal economic aspects of common carrier operation recognized by law. The findings are summarized below.

I. Certificates of public convenience and necessity have been granted or withheld chiefly because of: (1) fitness of the applicant (not considered here); (2) relative merit of the service and its effect on competing rail and motor carriers, and on highway traffic; and (3) the present and future need or "necessity" for the service.

II. As to the effect on rail carriers, trucks have competed successfully with railroads for many years in the transport of valuable, light, short-haul, and less-than-carload merchandise, though they have not taken over any major part of total rail freight. Limited competition between trucks and railroads appears to benefit the public by improving service. At any rate, the certification of motor carriers has little effect on the traffic volume of railroads since, if certain types of goods move most economically by truck, they will continue to do so by contract or private carrier, even in the absence of common carrier service.

Regarding the effect of common carrier service on competing motor carriers, it is significant that contract carriers haul as much or more inter-city tonnage than do common carriers because of basic advantages to the carrier (rather than to the public) of the contract type of operation. This view is supported by the fact that in California, where permits for contract operation are issued very freely as compared with certificates, contract carriers predominate much more than they do elsewhere. Yet common carrier service is believed to serve the whole public better, for reasons given in part II B.

Limited competition is desirable, but competition among contract carriers ap-

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* Professor of Business Statistics, Stanford University.

pears to be excessive in some regions. The degree of competition desirable among common carriers may be inferred from a survey of eight typical overnight routes regulated by the Interstate Commerce Commission. These routes were served by an average of seven common carriers.

The effect of common carrier service on highway traffic appears to be minor, since: (1) its volume is small compared with that of total traffic; (2) it operates week-day nights when general traffic is light; and (3) if goods move economically by truck, they will move by private or contract carrier even in the absence of common carrier service.

III. The growth in the "public convenience and necessity" for truck service has been phenomenal. The current volume of inter-city motor ton-miles is 4.3 times that of the prosperity year 1929, according to the index presented here, as compared with 1.7 times for all freight carriers combined.

Finally, the future public need for motor freight service has been projected ahead to 1960 by relating transportation demand to forecasts of total production. Population forecasts were first combined with estimates of employment, the declining trend in working hours per week and the rise in real output per man-hour to produce past and future estimates of total production of goods and services for the century 1860 to 1960. Production is expected to gain substantially over the next twelve years despite cyclical recession from current boom levels. The resulting forecast of freight demand in 1960 is nearly five times that of 1929, even on the the conservative assumption that trucks make no further inroads into rail traffic.

[1] Interstate Commerce Act, Part II, Section 207.

[2] Stuart Daggett, *Principles of Inland Transportation*, 3rd Ed. (Harper: 1941), p. 634. See also "Certification of Motor Common Carriers by the Interstate Commerce Commission" II, J. J. George and J. R. Boldt, Jr., *Journal of Land & Public Utility Economics*, 1941, pp. 196-206.

It is believed that this rapidly growing public need for motor freight service may be best satisfied by the further development of well-regulated *common* carrier service, as it has been for railroads.

I. The Basis for Granting Certificates

There are three broad factors that have generally been considered by the Interstate Commerce Commission and by state commissions in granting or withholding certificates of public convenience and necessity for common carrier operation. First is the question whether the applicant is "fit, willing, and able properly to perform the service proposed and to conform to the provisions of this part and the requirements, rules, and regulations of the Commission thereunder."[1] Second is the relative merit of the proposed service, and its effect on competing rail and motor carriers. This will be taken up in Part II. Third is the past and future growth in the public need for the service—covered in Part III.

In considering the first factor, the Interstate Commerce Commission has usually investigated: (1) the successful experience and efficiency of the applicant, (2) his financial responsibility, and (3) the equipment, facilities and service to be offered.[2]

The state commissions, too, have endeavored to protect the shipping public against irresponsible, inadequate and expensive service, and the investor against the loss of capital in enterprises which have no reasonable prospect of success.[3] Motor service can be started with very little capital or experience. Regarding contract carriers, the Railroad Commission of California reported that:

"Lack of proper financial strength, experience in and knowledge of truck transportation have resulted in over two-thirds of the

[3] *Bridge Bus Lines Corporation, Application*, 40 California Railroad Commission, 542, 553-554 (1937).

carriers licensed being out of business within one year, only to be followed by others who drop out of the field within a similar period."[4]

While the applicant himself is an important consideration, this report cannot of course evaluate the individual merits of carriers, but rather will consider only the other general factors described below.

II. Merit of Additional Common Carrier Service and Its Effect on Existing Rail and Motor Carriers and on Highway Traffic

This factor is of major importance since the Interstate Commerce Commission recognizes an obligation to protect existing carriers in order to maintain a degree of stability among them sufficient to insure efficient service to the shippers.

". . . the maintenance of sound economic conditions in the motor-carrier industry would be jeopardized by allowing new operators to enter a field in competition with existing carriers who are furnishing adequate, efficient, and economical service."[5]

It is clear, however, from an examination of cases in which certificates are sought, that if the operations of the applicant will provide a better or more suitable service than is provided by existing carriers, whether rail or motor, the Commission will not hesitate to authorize competitive service, notwithstanding the adverse effect it may have on existing carriers.[6] The question of what type of carrier provides a "better or more suitable service" will therefore be taken up, comparing first the merits of truck and rail transport service and second the advantages of common carriers versus contract carriers.

A. Relative Merits of Truck and Rail Transport Service

1. Types of Goods that Move by Truck. For many years trucks have competed successfully with railroads for certain types of transport, particularly, (a) for valuable, light merchandise, (b) for short hauls, and (c) for less-than-carload traffic. These types are discussed below:

(a) The adaptability of trucks to hauling valuable, light merchandise has been frequently cited,[7] and is shown by the fact that average revenues per ton mile of Class I motor carriers are about four times those of railroads, according to the Interstate Commerce Commission.[8]

(b) The principal advantage of truck service over rail transport for short hauls lies in the ability of the truck to furnish overnight service.[9] In fact, the optimum operating range of the truck is probably determined by the radius of overnight delivery:[10]

"The practice of the larger trucking companies is to operate their trucks over the road during the night when other traffic is comparatively light. Truck-load shipments move direct from plant to consignees' store door. Less-than-truck-load shipments move to the freight transfer station which the larger trucking companies maintain, where each shipment is trans-shipped to a small or local delivery truck . . . Less-than-carload shipments by rail require local motor truck de-

[4] State of California, Railroad Commission, *Annual Report, 1945-1946*, p. 134.

[5] *Clark*, 1 M.C.C. 445 (1937), at p. 448, citing *C. & D. Oil Co.*, 1 M.C.C. 329 (1936). See also *Hypes Extension*, 16 M.C.C. 543, 544 (1939). This principle has been repeatedly cited by the Commission, according to Mr. W. Y. Blanning (letter of April 23, 1948).

[6] See *Bowles*, 1 M.C.C. 589, 591 (1937) and *Brady Transfer*, 23 M.C.C. 767 (1940), in which communities are said to be entitled to adequate service by motor vehicle as well as by rail; *All-American*, 18 M.C.C. 755, 776 (1939) and *Airline*, 24 M.C.C. 117 (1940), in which it was pointed out that the advantages to those using the proposed service may outweigh the disadvantages to existing service that may result; *Kansas City*, 28 M.C.C. 5, 21 (1941), holding that the public should not be deprived of an improved service merely because it might divert traffic from other carriers; and *West Coast*, 41 M.C.C. 269, 290 (1942), and *Mt. Hood*, 44 M.C.C. 535, 548 (1945), regarding authorization of an additional carrier where a monopoly existed.

[7] 8 M.C.C. 287, 302 (1938). Also D. P. Locklin, *Economics of Transportation*, 3rd Ed., (Chicago: R. D. Irwin, 1947), p. 689.

[8] I.C.C. *Annual Reports* and I.C.C. *Statistics of Class I Motor Carriers*.

[9] Daggett, *op. cit.*, pp. 93-94.

[10] H. G. Moulton, *The American Transportation Problem* (Washington, D. C., Brookings Institution: 1933), p. 524.

livery . . . This procedure is time consuming."[11]

(c) The advantages of trucks over railroads for hauling merchandise less-than-carload traffic in general have caused the diversion of the greater part of this traffic to the motor carriers. The Interstate Commerce Commission's ratio of l.c.l. railway freight tonnage to potential tonnage based on production declined from 100% in 1928 (the base year) to 37.6% in 1942 and recovered only to 41.4% in 1944 (when wartime restrictions hampered trucking), since "this class of traffic [is] highly vulnerable to competitive forms of transport."[12] By 1946 the highway movement of freight between San Francisco and Los Angeles had become eight times that of the railroads' overnight merchandise trains, to cite an extreme example.[13]

2. Reasons for Using Trucks. The principal reasons given by 35,468 shippers for using trucks, according to a 1934 survey were, in the order given: faster service, store door delivery and pick-up, cheaper total cost and more flexible or convenient service. A recent survey revealed the following reasons, again in order of importance: shorter transit time, lower cost, and less handling of freight with consequent reduced risk of damage.[14] Hence, while the railroads now offer pick-up and delivery service, trucks still offer advantages in faster and cheaper service, particularly on short-haul merchandise traffic.

According to the National Resources Planning Board:

"Merchandise business appears ill-adapted to rail haulage . . . It is clearly evident that much of the less-than-carload business is handled at a substantial loss to the carriers . . . Not only have the costs been increased by the necessity of faster service and the provision of pick-up and delivery service, but the traffic has been greatly diluted by the inroads of motor competitors, forwarders and other types of carriers."[15]

The Interstate Commerce Commission reports that:

"In the recent general class rate investigation it was shown that less-than-carload traffic generally in all the territories is not bearing its proper share of the costs of transportation—in fact, excluding wartime loading, it is not yielding, on the average, its out-of-pocket costs plus constant expenses solely related to this traffic, plus the cost of collection and delivery . . ."[16]

3. Effect on Railroads. Despite the advantages of motor transport for valuable short haul less-than-carload merchandise, however, trucks have not taken over any large part of total rail traffic. In 1946 the railroads hauled more than nine times as many inter-city ton-miles as did the motor carriers.[17] As to income, the non-passenger operating revenues of steam railways in the United States were nearly four times those of motor carriers of property in this year, according to Interstate Commerce Commission reports on carriers under its jurisdiction.[18] Much of this motor transport is, of course, non-competitive with railroads.

Nor has motor transportation been particularly profitable in recent years. The operating ratios of Class I motor carriers of property averaged 95% in the pre-war years 1939-1941, then rose to 99.8% under the wartime restrictions

[11] R. W. Talbot, "Why Shippers Use Trucks," *Railway Age*, Sept. 26, 1931, p. 485.

[12] Interstate Commerce Commission, *Fluctuations in Railway Freight Traffic Compared With Production*, November 1946 (mimeo.), p. 17.

[13] J. G. Hunter, *Second Study Dealing with the Movement of Property . . .*, State of California Public Utilities Commission, Jan. 27, 1947, p. (d).

[14] Federal Coodinator of Transportation, *Merchandise Traffic Report*, 1934, pp. 25, 293, and Association of American Railroads, *Transportation in America*, (Washington, D. C. 1947), p. 202.

[15] National Resources Planning Board, *Transportation and National Policy* (Washington, D. C., U. S. Gov't Print. Off., 1941), pp. 58-59.

[16] I. C. C. *60th Annual Report*, Nov. 1, 1946, p. 40.

[17] I. C. C. *61st Annual Report*, Nov. 1, 1947, p. 7.

[18] *Ibid.*, pp. 6, 170.

of 1945, and dropped only to 96.4% in 1946, according to Interstate Commerce Commission annual reports. On the other hand, the losses by railroads to motor carriers have been largely offset by the rise in traffic due to the rapid growth of general industry since 1932.

The effect of truck development on existing rail carriers, therefore, has not been a major one, except in the merchandise less-than-carload category which has always been a minor part of rail traffic.

4. Desirability of Competition. It appears to be good public policy to foster competition between trucks and railroads. The basic principle of limited competition has been affirmed repeatedly by the regulatory authorities:[19]

"So long as private profit remains the incentive for carrier service, competition in service, restrained within reasonable limitations, must also remain if the service is to be kept efficient and economical."

In the Far West, for example, competition with truck lines has led the Southern Pacific railroad to cut the time schedule on its merchandise run between San Francisco and Los Angeles from third morning delivery to overnight delivery,[20] to the public's benefit. This advance in speed is comparable to that of the automobile over the horse and buggy. Rail rates have also been cut by competition[21] to the benefit of the public, although to some detriment to the railroads themselves.

Furthermore, federal and state governments generally follow the policy of supporting smaller business,[22] such as motor carriers, to the extent that these concerns have a reasonable chance of success.

5. Futility of Protecting Railroads

According to Locklin:[23]

"There are two objections to the policy of denying certificates to motor carriers for the purpose of protecting the railroad. First, such a policy, if effective, deprives the public of a service that is often superior and sometimes cheaper than rail service . . . The second difficulty . . . is that it is largely futile. If common carriers and perhaps contract carriers are denied the right to operate, the shipper who has substantial and frequent shipments to make can perform his own transportation service . . . The railway is competing with the highway, not simply with carriers for hire operating over the highway. Only the small shipper, who cannot afford to do his own trucking, is forced to patronize railways if certificates are denied to common carriers."

The certification of motor carriers, therefore, has little effect on railroad traffic. If certain types of goods move most economically or rapidly by truck, they will continue to do so by contract or private carrier even in the absence of common carrier service. Competition between common and contract motor carriers appears to be more sensitive to regulatory control than does that between trucks and railroads.

B. Relative Merits of Common Versus Contract Carrier Service

1. Comparison of Tonnage Hauled. Contract trucks on the road in 1940 outnumbered common carriers 1.2 to 1, according to highway checks in 34 states.[24] During the war, the mileage

[19] Federal Coodinator of Transportation, *Freight Traffic Report, 1935*, Vol. I, p. 108. See also *West Coast* and *Mt. Hood* cases cited in footnote 6; *Associated Transport*, 38 M.C.C. 137, 150-163 (1942); *Illinois Greyhound*, 38 M.C.C. 641 (1942); *Southwestern Greyhound*, 39 M.C.C. 721 (1944); *Greyhound Corp.*, 45 M.C.C. 83 (1946); and *Eastern-Central*, 321 U.S. 194, 206 (1944).

[20] J. G. Hunter, *Study Dealing with the Transportation of Freight Traffic . . .*, California Railroad Commission, May 27, 1946, pp. 25-27; Second Study, *op. cit.*, p. (c).

[21] R. B. Thompson, *A Study Showing Development of Trucks . . .* Truck Owners Association of California (San Francisco, mimeo., 1946), pp. 30-32.

[22] Committee for Economic Development, *Meeting the Special Problems of Small Business* (Chicago: 1947).

[23] D. P. Locklin, *Economics of Transportation* Revised Ed. (Chicago: Business Publications, 1938), p. 809.

[24] Association of American Railroads, Regional Research Department, Eastern-Southern Region, *State Highway Planning Surveys* (N. Y.: mimeo., 1940), Table 2.

certified by the Office of Defense Transportation for all contract carriers exceeded that for intercity and local common carriers combined, though the common carriers consumed more fuel.[25] In the future, the proportion of total motor traffic handled by common carriers may decline below the pre-war level, according to a 1947 estimate.[26]

In certain regions, however, contract carriers have a much greater advantage than shown above. Between San Francisco and Los Angeles, for example, contract carriers outpull common carriers about 5 to 1 both in total tonnage and in general commodity traffic, according to road checks conducted in 1946.[27]

2. Advantages of Contract Carriers. It would appear, therefore, that contract carriers have an advantage over common carriers on the average, throughout the country, and that in California, at least, they have nearly eliminated common carriers. The chief reasons why contract carriers carry as much or more tonnage than do common carriers generally throughout the country are:

1. They need not offer general service. They can specialize on uniform, profitable truckload traffic, perhaps leaving only the less profitable small-package business for the common carrier.
2. They can wait for a full load, whereas common carriers often must make trips partly empty.
3. They can use any route, and therefore can sometimes achieve greater speed in delivery on off-route destinations.
4. They need maintain no terminal facilities.
5. They are not held to any maximum rates.
6. No insurance bond is required in some states.
7. State fees and taxes are lower.
8. No reports are required by state commissions for Class II and III contract carriers.
9. Less capital is required to become a contract carrier than a common carrier. One truck is sufficient.[28]

On the other hand, the chief reason for the much greater preponderance of contract carriers over common carriers in California, as compared with other regions, seems to be the relative ease of securing permits. Since the war the California Railroad Commission has been deluged with a flood of applications for permits, nearly all of which have been granted. According to the Commission's Annual Report for 1944-45 (page 120): "It is mandatory upon the Commission to issue permits to all new applicants."

In contrast, no certificates of public convenience and necessity have been issued for common carrier service for the transportation of general commodities between San Francisco and Los Angeles, the state's two principal industrial areas, since 1933. The two common carrier groups in the field since then[29] have apparently not had the facilities and service to compete with the contract carriers since the latter have taken over five-sixths of the traffic, as noted above.

Because of the advantages outlined above, contract carriers are able to render the public an invaluable service, particularly in transporting special types of commodities over irregular routes. Many of the particular benefits of contract operation, however, accrue to the companies themselves, rather than to the public, and thus enable them to compete successfully with the common carriers.

3. Advantages of Common Carriers. On the other side of the picture, common carriers offer certain important advan-

[25] Office of Defense Transportation, *A Review of Highway Transport and Transit Industries During the War*, Nov. 30, 1945, p. 150.

[26] Association of American Railroads, *Transportation in America* (Washington, D.C., 1947), p. 307. I.C.C. statistics of Class I carriers are misleading in this respect, since smaller concerns and intrastate carriers are excluded.

[27] J. G. Hunter, Study of May 27, 1946, *op. cit.*, Tables 1 and 2; Second Study of Jan. 27, 1947, *op. cit.*, p. 16, Table A-12 Sheet 3.

[28] See D. P. Locklin, *Economics of Transportation*, Rev. Ed. *op. cit.*, pp. 811-812, also 3rd Ed. *op. cit.*, pp. 730-732 for further discussion.

[29] (a) Valley Express Co. and (b) California Motor Express-Coast Line Express.

tages to the public, particularly in the haulage of general commodities over regular routes, which advantages seem to justify their encouragement by regulatory commissions:

1. The major public benefit of common carriers is that they serve the whole public, including small business generally, which the state has an interest in aiding.[30]

"Contract operators tend to concentrate on the traffic of large shippers who can provide a substantial volume of business. In the absence of common-carrier service, the mall shipper is therefore at a disadvantage, for it is often uneconomical to provide his own transportation."[31]

2. They accept nearly all types of commodities, including less-than-truck-load lots of small size.
3. They operate on regular schedules, as the railroads do, thus enabling the small shipper to plan his operations ahead.
4. They maintain terminal facilities.
5. They must adhere to the rates filed, unlike contract carriers, (who are held to minimum but not maximum rates). This stability of rate structure benefits shippers since many business transactions involve calculations based on estimated future freight rates.
6. They pay higher fees to the state.
7. They are subject to closer scrutiny and control by the regulatory commission, which is a protection to the public.[32]

The Interstate Commerce Commission has reiterated the principle of supporting common carriers for some of the above reasons:

"The underlying purpose is plainly to promote and protect adequate and efficient common carrier service by motor vehicle in the public interest, and the regulation of contract carriers is designed and confined with that end in view."[33]

Again,

"Common carriers, since they undertake to serve the general public, should be protected against contract carriers who take the cream of the traffic and thus make it difficult for the common carriers to continue their broader operations."[34]

The need for encouraging common carriers is illustrated by California's dilemma, where most of the inter-city traffic is handled by a large number of small contract carriers rather than by a few larger ones. According to road checks in 1946, the 18 leading contract carriers and the two common carriers together moved only 40% of the total traffic between Los Angeles and San Francisco.[35] Speaking of contract carriers generally, the California Railroad Commission reported that:[36]

"Over 70 per cent of the applicants have never before engaged in for-hire operations in California . . . The records show that well over 60 per cent of the permittees licensed will be out of the trucking business within a year. It is our opinion that many of the applicants for permits lack proper educational background, are in poor financial condition and do not have any true comprehension of the responsibilities of a public carrier."

It would seem to be good public policy, therefore, to issue certificates more readily and permits more sparingly, according to California's experience.

4. Degree of Competition Desirable. If the encouragement of common carrier service is in the public interest, therefore, just what degree of competition is desirable among these carriers? The law reveals only that the principle of *limited* competition is well accepted, and that certificates

[30] Committee for Economic Development, *op. cit.*

[31] T. C. Bigham, *Transportation* (New York: McGraw Hill, 1946), p. 138.

[32] Advantages 3 to 7 are cited in Locklin 3rd Ed., *op cit.*, pp. 701-702 and Hunter's study of May 27, 1946, *op. cit.*, pp. 2, 30-31.

[33] *Contracts of Contract Carriers*, 1 M.C.C. 628, 629 (1937). See also *Filing of Contracts by Contract Carriers*, 20 M.C.C. 8, 11 (1939) and *New England Motor*, 30 M.C.C. 651, 661-665 (1941).

[34] *Gollock*, 1 M.C.C. 161, 165 (1936). Specifically, common carriers should be protected against the needless competition of, but should not be promoted at the expense of, contract carriers. See *Raymond Bros.*, 22 M.C.C. 427 (1940); *Petroleum Products*, 32 M.C.C. 453 1942(); *United Parcel Service*, 43 M.C.C. 689 (1944); *Williams Brothers Corp.*, 44 M.C.C. 557 (1945); and *National Transportation Policy*, enacted Sept. 18 1940 (U.S. Code Title 49, note preceding Sec. 301).

[35] J. G. Hunter, May 27, 1946, *op. cit.*, p. 22.

[36] *Annual Report*, 1944-1945, p. 120.

are properly denied when they might result in excessive or injurious competition. As a measure of the degree of competition considered desirable, the policy of the Interstate Commerce Commission may be cited for a group of eight cities selected as being of from 600,000 to 2,000,000 population, separated by overnight, interstate runs of from 300 to 500 miles. The results are shown below:

AN AVERAGE OF SEVEN COMMON CARRIERS CONNECT MEDIUM-SIZED CITIES SEPARATED BY OVERNIGHT RUNS[37]

ROUTE	Combined Population of Cities Served, 1945 (Thousands)	Trucks Registered in both Cities, 1946 (Thousands)	Highway Distance Apart (Miles)	Number of Common Carriers Connecting
Baltimore–Buffalo	1,528	39	414	9
Baltimore–Cleveland	1,797	53	355	8
Boston–Buffalo	1,398	35	471	4
Buffalo–Washington, D. C.	1,448	31	455	6
Cleveland–Washington, D. C.	1,717	45	351	7
Milwaukee–St. Louis	1,431	50	395	7
Minneapolis–Milwaukee	1,118	35	347	11
Minneapolis–Kansas City	1,115	36	471	5
Average, 8 Routes	1,444	41	407	7

While the above table shows that seven common carriers serve the cities listed, on the average, the *Motor Carrier Directory and Routing Guide* reports that some of these carriers are certificated only one way, so the average round-trip service is by six carriers. While this number of common carriers is not necessarily an optimum one, nevertheless it may be of interest as the actual number the federal commission has certificated on such routes under its jurisdiction. Of course, many of these carriers were licensed under the "grandfather clause," but the later certification of any additional carrier on a given route would tend to cloth all existing carriers with "public convenience and necessity."

This comparison covers only common carriers. Where there is but little common carrier service, and where competition among contract operators is already excessive, as in California, it is possible that the certification of additional common carriers would actually decrease this competition rather than increase it. The entry in the field of larger, well-equipped common carriers offering general commodity service to the whole public on regular schedule might replace some of the sporadic service now offered individual shippers by smaller contract operators. The public benefits of this transfer are listed above.

C. The Effect of Additional Common Carrier Service on Highways and on Highway Traffic

This factor is sometimes considered by commissions in considering applications

[37] Population data as of Jan. 1, 1945, and truck registrations as of July 1, 1946 as compiled by R. L. Polk & Co. were taken from the Automobile Manufacturers' Association's *Automobile Facts and Figures 1946-1947* (Detroit, 1947), pp. 26-27. Highway distances are taken from a Conoco Mileage Chart. Numbers of common carriers were taken from the American Trucking Associations' *Motor Carrier Directory and Routing Guide, Fall, 1946* (Washington, D. C.).

for certificates of public convenience and necessity, but it appears to be of minor importance, since: (1) Common carrier trucks make up only about four per cent of total vehicular traffic;[38] (2) Truck traffic complements passenger traffic, in that: (a) trucks operate at night when passenger traffic is lightest;[39] and (b) trucks operate weekdays, whereas passenger traffic is heaviest weekends.[40]

Since highways must be built for maximum traffic loads rather than for average traffic, the operation of trucks on off-hours and off-days, as compared with passenger cars, increases the average utilization of highways and hence increases their efficiency in use.

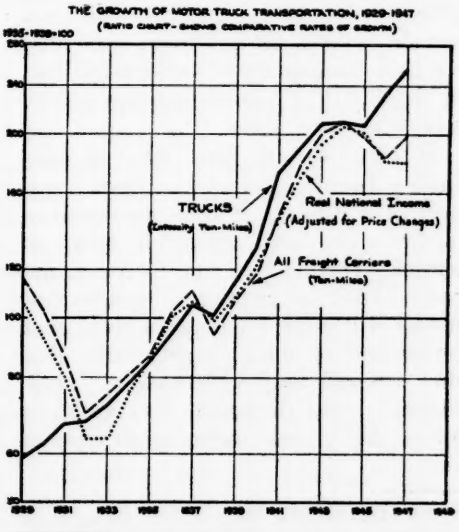
(3) At any rate, the question of the effect of trucks on highway traffic and highway wear does not seem to be pertinent here, since if goods move economically by truck, they will move by private or contract motor carrier if they do not move by common carrier.

III. The Growing Need for Motor Transport Service

This study so far has compared the merits of common carrier truck service with those of competing types under static conditions of traffic demand. In the present section, therefore, the growth in trucking is traced from 1929 to 1947 to show the extent of the present public "necessity" for this service. While the growth of total truck transport is contrasted with that of rail and other carriers, no distinction is made here among the particular types of motor carriers, since the rise in the demand for total trucking facilities should indicate a corresponding rise in the need for common carrier service itself.

Finally, since the Motor Carrier Act of 1935 authorizes the Interstate Commerce Commission to issue certificates if required by present *or future* public convenience and necessity (Section 207) the demand for trucking service in the United States will be projected into the future. This forecast will be extended as far as 1960, since the prerequisite estimates of national income cited in the next section are available to this date. The study of *future* needs is a logical one, since either certification or any other regulatory policy is effective only in the future.

A. Past Growth, 1929-1947. The chart shows the spectacular growth of inter-city truck traffic since 1929, as compared with the more moderate rise in total tonnage of all freight carriers (including railroads, air lines, water carriers and pipe lines as well as motor carriers).[41]



[38] Estimated from 1946 total truck count as 18.3% of all vehicles in 48 states (*Public Roads*, March 1948, p. 44), with common carriers comprising 20 to 25% of total truck traffic Association of American Railroads, *Transportation in America*, (Washington, D. C., 1947), p. 307.

[39] J. G. Hunter, Jan. 27, 1947, *op. cit.*, Appendix Tables A-4 and A-5 show hourly truck counts for 1946.

[40] Bureau of Public Roads, *Report of a Survey of Traffic on the Federal-Aid Highway Systems of Eleven Western States* (1930), pp. 4-5; still valid today.

[41] U.S. Department of Commerce transportation indexes are used from *Survey of Current Business*, Sept. 1942, May 1943, Mar. 1944, Mar. 1945, Mar. 1946 and Feb. 1947 (p. 23), supplemented by recent estimates of the Automobile Manufacturers' Association.

Each series is plotted as index numbers based on its 1935-1939 average as 100 per cent, using a semi-logarithmic scale which shows similar rates of growth as parallel lines.

The trucks' most noteworthy gain over railroads came during the general collapse of 1929-1932, when truck ton-miles gained steadily. Over the following decade of recovery trucks gained only slightly on other modes of transport, though they were again relatively immune from the 1938 depression. During the war, trucking was limited by restrictions on gasoline and equipment, but under the freer conditions of 1946 and 1947 truck tonnage boomed to an all-time high while other traffic remained below the war peak. The current volume of truck ton-miles is 4.3 times that of the prosperity year 1929, as compared with 1.7 times for all freight carriers combined. These figures of course show only the growth in the actual public use of truck service, and not the unsatisfied need arising from inadequacy of trucking facilities or the dearth of regular common carrier service in some areas.

B. Future Growth, 1948-1960. In forecasting the future demand for truck transport, it is difficult to assess the extent of further gains over competing forms of service. For the long run, therefore, the conservative assumption is made that trucks will soon have taken over that proportion of total freight traffic that they are well adapted to handle. Their tonnage trend thereafter is expected to follow that of total traffic by all types of carriers.

1. Methods of Forecasting Production. The trend of total freight traffic tends to follow the general volume of industrial production and trade (barring extensive industrial decentralization), since nearly all goods must be transported by some type of carrier at every stage from the original producer to the consumer.[42] If we can forecast production, therefore, we can infer what the demand for freight traffic will be.

The best measure of total output is believed to be "real" national income:

> "On the whole, it appears more reasonable to rely on over-all measures of productivity (*i.e.*, in terms of national income or gross national product) in projecting past trends rather than on indexes of productivity in specific industries or occupations that are not representative of the entire economy.[43]

The chart shows the Department of Commerce estimates of national income "deflated" by means of the Bureau of Labor Statistics Consumer Price Index (corrected for its own downward bias) in order to remove the effects of price changes.[44] Total freight tonnage is seen to have followed real national income closely since 1929, and will probably continue to do so in the future.

2. Forecast of Total Production to 1960. Estimates of national income, deflated for price changes, have recently been projected ahead to 1960 in an exhaustive study by the Twentieth Century Fund entitled, *America's Needs and Resources*, published in May 1947.

In this study, population is first forecast to 1960 on the "high fertility, medium mortality" assumptions of Thompson and Whelpton's 1943 study,[45] which now appear conservative.[46] The relative size of the labor force is then projected ahead at about 39 per cent of the population.

[42] See I.C.C. Bureau of Transport Economics and Statistics, *Fluctuations in Railway Freight Traffic Compared with Production*, Nov. 1946 (mimeo.).

[43] J. F. Dewhurst and Associates, *America's Needs and Resources* (New York: The Twentieth Century Fund: 1947), p. 22.

[44] Income data are from *Survey of Current Business*, July 1947, *National Income Supplement*, and Jan. 1948. B.L.S. price indexes are corrected in 1941-1944 by E.E. Hagen in *Review of Economic Statistics*, May 1945, and in 1945-1947 by W. A. Spurr.

[45] National Resources Planning Board, *Estimates of Future Population of the United States, 1940-2000*, (Washington, D. C., U.S. Gov't Print. Off., 1943).

[46] P. K. Whelpton, *Forecasts of the Population of the United States, 1945-1975*, Bureau of the Census, 1947, p. 39f.

Anticipating "full" employment, only five per cent of this force is assumed to be unemployed, as in the late twenties. Then the average length of the working week is expected to contract. Multiplying the number of employed by average weekly hours by 52 weeks gives estimates of annual man-hours worked in 1950 and 1960. Finally and most significantly, output per man-hour is projected ahead at an increase of 18.2 per cent per decade, the same average rate as computed for the past century. Multiplying this average output by total man-hours yields estimates of national income in 1950 and 1960 at 1940 prices.

Before using the Twentieth Century Fund forecasts of national income, however, it was necessary to make three adjustments to them:

(1) Estimates of past income were increased following a revision of national income data for the period 1929-1946 published by the Department of Commerce in July 1947.[47]

(2) The estimates were raised by using income in the postwar years now available, as the springboard for the forecast. The Twentieth Century Fund study had no postwar figures to work on, and hence had to use 1940 as a base, the war years being unduly inflated for this purpose.

(3) The Fund seemed unduly optimistic in assuming that only five per cent of the labor force will be unemployed in the future, so this figure has been increased to 8 per cent (the average level from 1889 to 1926 according to Paul Douglas),[48] on the basis that the most probable future expectancy will be midway between prosperity and depression.

The revised estimates are shown in the Table below. They are not far from the original ones, (*America's Needs and Resources*, p. 23), but are more conservative in assuming average business conditions rather than "full" employment. This accounts for the decline in 1950 from the high prosperity level of 1946 and 1947. The 15-per-cent growth from 1950 to 1960 reflects the expected gains in labor productivity more than population growth or any change in the business cycle.

[47] *National Income Supplement to Survey of Current Business, op. cit.*

REVISION OF NATIONAL INCOME ESTIMATES 1940-1960
(*Billions of Dollars, 1940 Prices*)

	Twentieth Century Fund	Spurr	% Increase (Col. 3/Col. 2)
1930....	$ 62.9	$ 62.9	0
1940....	77.6	81.3	4.8
1944....	121.7	138.1	13.5
1946....	.....	122.1	.....
1950....	106.	117.8	11.1
1960....	122.	135.9	11.4

3. Forecast of Freight Traffic Demand. The index of inter-city truck ton-miles shown in the chart may now be projected ahead to 1960 on the assumption that it will follow the trend of total production. While a slight decline is indicated by the income data between 1946 and 1950, freight traffic actually rose some ten per cent between 1946 and 1947 with the release of wartime restrictions and the availability of new equipment. The assumed cyclical decline in business activity from the present high level might even benefit truck traffic further, because of the competitive advantage of lower-cost trucking over railroads in depression periods. The demand for trucking is, therefore, expected to rise further over the next several years, despite the slight decline in production indicated above. From 1950 to 1960, however, truck demand may be expected to increase more in line with the 15 percent gain in total production. By that time, the truck tonnage index of the chart should be well over 300, or five times the 1929 level.

The future "public convenience and necessity" therefore will require considerably expanded trucking facilities of all types. The encouragement of common carriers, in particular, appears to be sound public policy in order to meet this anticipated need.

[48] *Real Wages in the United States, 1890-1926* (New York: Houghton Mifflin, 1930), pp. 440, 460.

Range Forage Conditions in Relation to Annual Precipitation†

By MARION CLAWSON*

THREE-FOURTHS of the western half of the United States is used largely for the production of range forage. For the most part, range forage production secured this vast area by default; that is, for lack of a more profitable alternative use.

"It supports with few exceptions only native grasses and other forage plants, is never fertilized or cultivated, and can in the main be restored and maintained only through control of grazing. It consists almost exclusively of lands which, because of relatively meager precipitation or other adverse climatic conditions, or rough topography, or lack of water for irrigation, cannot successfully be used for any other form of agriculture."[1]

Chief among the factors which restrict range land to the production of native plants for livestock forage is probably low annual precipitation. There are comparatively few range areas which will not produce more forage in a year of relatively high annual precipitation than in a year of relatively low annual precipitation. An unfavorable seasonal distribution of precipitation may render a relatively high annual total precipitation less effective, of course, but in the main it is total annual precipitation which dominates total forage production on any given site. If annual precipitation in many range areas were somehow to be permanently increased, other factors, such as growing season, soil depth, or soil fertility, might become limiting. Under present conditions, limited annual precipitation is the primary or major cause of limited forage production on most range lands, and other factors are of secondary importance. These facts do not in the least deny the importance of conservative and sound range management to take full advantage of such moisture as does fall but, on the contrary, do reinforce the need for such management.

Any attempt to deal quantitatively with the effect of annual precipitation upon range forage production is handicapped by the lack of suitable measures of forage production on range land. In the nature of things the forage produced is harvested by livestock. The number of livestock that can be supported upon a given area, or the amount of meat or other production from these livestock, can be used as one measure. Aside from the fact that the degree of utilization of available forage may differ between years or areas, livestock production is influenced by many factors other than availability of feed, and hence this measure has its shortcomings. There is often a considerable lag between the time grazing occurs and the time when the results in terms of livestock production show up which further limits this measure on seasonal ranges. Another attack on the problem is actually to clip or cut the plant growth from sample areas. Not all of the growth so cut may be usable by livestock, and the proportion may vary from one year to another. Moreover, such a method is expensive and has not been widely employed.

† Some of the clerical work on this study was performed by employees of the Bureau of Agricultural Economics and the author's early work in this field was done while employed by that agency. Neither the Bureau of Land Management nor the Bureau of Agricultural Economics should be held responsible for the viewpoints expressed herein.

* Bureau of Land Management, U. S. Department of the Interior.

[1] *The Western Range*, Senate Document No. 199, 74th Congress, 2nd Session, 1936. p. 2.

This article will make use of another measure of range forage production, the "range condition" figures collected monthly by the Bureau of Agricultural Economics. Seasonal movements of this index by states and regions, statistical distribution of monthly indexes, regularity of change from month to month, relation of the index of range condition to annual precipitation, and the relation of the index of range condition to the indexes of livestock condition are considered in this article. It concludes with a brief discussion of the economic usefulness of the results obtained.

Experimental Data

Before considering the BAE range condition data, a brief review of some of the major experimental findings in this field will be useful. In the main, experimental work has dealt with limited areas and for too few years for wholly satisfactory statististical analysis. The relatively high cost of work in the field is undoubtedly a major factor. Experimental results are therefore more suggestive than conclusive.

An early work in this field was USDA Technical Bulletin No. 409, April 1934, *The Influence of Precipitation and Grazing upon Black Grama Grass Range*, by Enoch W. Nelson. The studies on which it was based were made between 1915 and 1927. Part of the conclusions of the study were stated as follows:

"The increase or decrease in the area of black grama from one fall to the next is influenced mainly by the vigor of the plants at the start of the current growing season, as reflected by the previous year's or even by the previous summer's precipitation. Current summer-seasonal rainfall has no significant effect on current change in plant density. Ordinarily one favorable growing season appeared to be necessary to restore the vigor of weakened plants before marked improvement in stand began. On the other hand, it is the rainfall during the current summer season which largely determines the height growth during that season on the existing black grama stands."

An examination of data presented in the Bulletin shows a correlation of well over .9 (uncorrected for number of observations) between height growth and precipitation in the current summer. Examination of the data presented in the Bulletin leads to a conclusion that the climatic factors affecting density are more complex than the foregoing quotation would indicate; deficiencies or surpluses of precipitation in several preceding years seem to leave their influence upon plant density. Elsewhere in the Bulletin the author concedes this also. By use of precipitation in several preceding years, the index of multiple correlation undoubtedly would be high. However, such procedure seems unwarranted in view of the few years of record. The Bulletin presents no data on volume of forage produced.

These results all apply to ungrazed lands. Forage production on conservatively grazed lands was equally great or greater, and the ranges recovered more rapidly following drouth. Heavy overgrazing reduced forage production greatly and greatly impaired the ability of the range to recover in favorable precipitation years.

Another major study in this field is USDA Technical Bulletin No. 600, February 1938, *The Influence of Climate and Grazing on Spring-Fall Sheep Range in Southern Idaho*, by G. W. Craddock and C. L. Forsling. The data presented in this Bulletin are for the 9 years, 1924 to 1932 inclusive. Part of the conclusions are stated as follows:

"The volume of forage produced varied from 41 percent above to 33 percent below the 9-year average, largely as a result of precipitation during the winter and spring season."

From data presented in the Bulletin, the

correlation between annual (October 1-Sept. 30) precipitation and number of sheep days of grazing per acre exceeded .75 (no correction for number of observations) on conservatively grazed paddocks. Practically the same correlations are obtained if winter-spring rather than annual precipitation is used. For severely overgrazed paddocks, the relation was less close; the range progressively deteriorated and the influence of a given amount of precipitation declined. Other climatic factors seem to have had only secondary or no influence upon forage production in the period studied, although a longer record might reveal significant influences.

A third major study is North Dakota Bulletin 308, December 1941, *Grazing Investigations on the Northern Great Plains*, by J. T. Sarvis. This Bulletin reports upon experiments conducted from 1916 through 1940. These experiments were conducted upon a different basis than the two previously described ones; forage production was here measured in terms of gains in animal weight, rather than in terms of plant growth or days of pasturing. Two-year-old steers, raised elsewhere than on the experimental range, were purchased each spring. They were sorted into groups as nearly alike as possible, and grazed on pastures at different rates of stocking. On the most heavily grazed pasture all the feed was consumed each year; on the more lightly grazed pastures some was left ungrazed in some or all years. Only on the most heavily grazed pasture, therefore, did gains in weight of animals grazed measure forage production. Since breeding animals were not kept, the differences in rates of grazing obviously did not affect calf crop, death loss, etc.; and they obviously were not cumulative in effect, because new animals were bought each year.

On the most heavily grazed pasture, the correlation between beef production per acre and annual precipitation was only .64 (uncorrected for number of observations). In 1916, the first year of the experiments, beef production was 50 percent above that anticipated on the basis of precipitation alone. This was largely due to the unusually favorable range conditions of 1914 and 1915, when the range was not fully utilized. In 1930, beef production per acre was only half that expected on the basis of precipitation. Apparently this was due in large part to a highly unusual seasonal distribution of annual precipitation. (Bulletin 308 is not wholly clear on this point.) If these two years be omitted, the correlation exceeds .85. Other climatic factors seem not to have been dominant or major in their importance. As pointed out previously, factors other than availability of forage influence meat production, even under the relatively simple conditions of these experiments.

As far as the present author can learn, the previously discussed studies represent the earliest and longest records of this type available in the United States. Shorter or more fragmentary studies have been made in the past, and experiments now under way should in time yield records for a long series of years. For statistical analysis of the effect of annual precipitation upon range forage production, a record of at least 20, and preferably more, years is necessary.

The three studies cited agree in showing the dominant influence of annual precipitation upon range forage production, while not denying the influence of other climatic factors also. Drawn from 3 geographic areas—the southwest, the intermountain region, and the northern Great Plains—and from different forage types, these results are suggestive but not conclusive. Observations similar to these have been made in other countries, but

as far as the present author knows, no long series of quantitative data are available.

The BAE Range Condition Data

Since October 1922 the Bureau of Agricultural Economics has collected estimates of "range condition" from its crop reporters in 17 western states. The same inquiry asked for information on the condition of cattle and calves, and of sheep and lambs. All condition figures are reported in "percentage points." The following is the form used in California in February 1947, which is substantially that used since the beginning of the inquiry:[2]

"*Report condition for your locality in percentage points*

The following guide is suggested; 100 percent and over represents an excellent condition such as might be expected when nearly all circumstances are favorable, 90-99 very good, 80-89 good, 70-79 fair, 60-69 poor, 50-59 bad, and 49 under very bad.

1. Condition of all PASTURES AND RANGES, about February 1....—%
2. Condition of all CATTLE AND CALVES, about February 1....—%
3. Condition of all SHEEP AND LAMBS about February 1....—%"

The question immediately arises: what do the farmers and ranchers to whom this inquiry is sent interpret "range condition" and "livestock condition" to mean, and what do they mean by "percentage points?" These are not easy questions to answer, but they are crucial. Some inferences may be drawn from the character of their replies.

First of all, it is almost certain that "range condition" as used in this inquiry and as reported upon by farmers and ranchers is not the same thing as "range condition" of the range management specialist. By range condition the latter means the relation between the present productive capacity of a range and its potential capacity; condition changes slowly as a range slowly deteriorates or is restored, while forage production may vary sharply and quickly as weather factors dictate. Upon this concept, it is unthinkable that range condition would fluctuate several points from month to month, or seasonally, as the rancher's variety of "range condition" will be shown to do. The rancher obviously has something else in mind; one is tempted to conclude that he means forage production, but this idea needs further examination before acceptance.

It is obvious also that the rancher's scale of "percentage points" is a subjective one, since neither the inquiry, nor literature commonly circulated, contains an objective definition and scale, capable of being applied by different persons with the same results. The subjectivity of the scale is not necessarily a drawback; the whole concept of crop condition is also and perhaps equally a subjective one, which has proved its utility. Two questions may be asked, however: (1) is the scale and standard of comparison reasonably constant, from month to month and from year to year, for any given rancher, or are his ideas of "excellent," "very good," "good," "fair," etc., unduly influenced by his most recent experience; and (2) are the scales of different ranchers in the same state or in different states sufficiently alike so that valid comparisons may be drawn among the resulting range condition figures?

Records for the 24 years, 1923 to 1946 inclusive, and for 17 western states, comprise 4896 state-months of data. These may be analyzed in various ways, e. g.; frequency by months for all states combined or frequency by states for all months combined, especially. With only 24

[2] Letter to the author from George A. Scott, Agricultural Statistician, California Crop and Livestock Reporting Service, June 11, 1947.

years of record, the data cannot well be analyzed for each month for each state; differences would too likely be due to chance.

About 40 percent of all state-months fall in the 80-89 range. (Table I) This conforms to the "good" category, as defined in the inquiry. Noticeable is the skew distribution of the entire frequency distribution. There are only 3 class intervals above the modal group, and 8 below it. A range condition of over 100 ("excellent") is relatively rare, achieved in only 2 percent of the state-months. There is clearly an upper limit to range condition, as ranchers use the term. There were almost as many state-months 49 or below ("very bad") and more between 50 and 59 ("bad"). These latter were relatively farther below the mode, at least in percentage points, than were the best months above it.

A similar skew distribution was found by months, as Figure 1 shows, for July and March. The distribution for these two months is remarkably similar except that the mode for July is about 1½ class intervals higher. Charts for other months show similar distributions, with intermediate modes.

These results check with unpublished studies by the present author on livestock production rates. Such ratios as calf crop, lamb crop, cattle and sheep death loss, and pounds of meat produced per animal in herd or flock, all seem to have skew distributions. It is hard to achieve results far above modal or typical results, but unusually bad results will sometimes occur. As a result, average performance over a long series of years is distinctly below typical or modal performance of most years.

Table I and Figure 1 obviously are influenced by conditions in the years for which records are available. If this was a typical sample out of the eternity of time, then the results represent what may be expected over a truly long period. The years from 1923 to 1946 included, in general, some fairly good years in the first third of the period, some very bad ones in the middle years, and some very good ones in the latter part of the period. At least all gradations of climatic conditions were included, but possibly not in proper proportions.

By combining all months for each state, frequency distributions by states can be obtained (Table II). The states are grouped into "regions." Because natural conditions vary so greatly in the large western states, no grouping into regions is wholly satisfactory. Particu-

TABLE I—NUMBER OF MONTHS WITH REPORTED RANGE CONDITION IN 17 WESTERN STATES COMBINED: 1923–1946 INCLUSIVE

Index of Condition	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
— 49	6	9	5	5	1	4	1	9	8	7	7	6	68
50 — 54	8	5	8	4	3	.....	4	9	7	11	7	7	73
55 — 59	3	12	7	5	5	4	5	7	9	5	9	10	81
60 — 64	15	10	16	9	11	6	12	12	14	14	10	5	134
65 — 69	25	21	21	20	9	17	18	18	23	20	28	27	247
70 — 74	54	53	49	41	29	23	20	25	38	41	45	48	466
75 — 79	53	72	57	61	63	35	37	59	54	59	50	61	662
80 — 84	90	79	93	86	102	73	55	57	87	80	82	87	971
85 — 89	96	89	86	99	87	99	83	94	75	75	80	88	1051
90 — 94	35	39	46	57	63	93	92	69	46	64	63	46	713
95 — 99	18	17	18	19	28	43	58	34	37	23	20	15	329
100 +	5	2	2	2	7	11	23	15	10	9	7	8	101
TOTAL	408	408	408	408	408	408	408	408	408	408	408	408	4896

larly troublesome are Wyoming and Colorado, each of which is roughly half Plains and half mountainous. They are included here with the Plains, because later parts of this analysis seem to indicate the range condition figures for those states more nearly resemble the comparable figures for Plains than for other states. But this procedure leaves only three "mountain" states, which greatly understates the importance of the great intermountain area. New Mexico is a partly plains, partly southwest, and partly mountainous state. Arizona is partly mountainous and partly southwest state. These difficulties of classifying states into regions exist for any regional grouping, but the advantages of bringing neighboring states into juxtaposition outweigh the nicety of a purely alphabetical grouping.

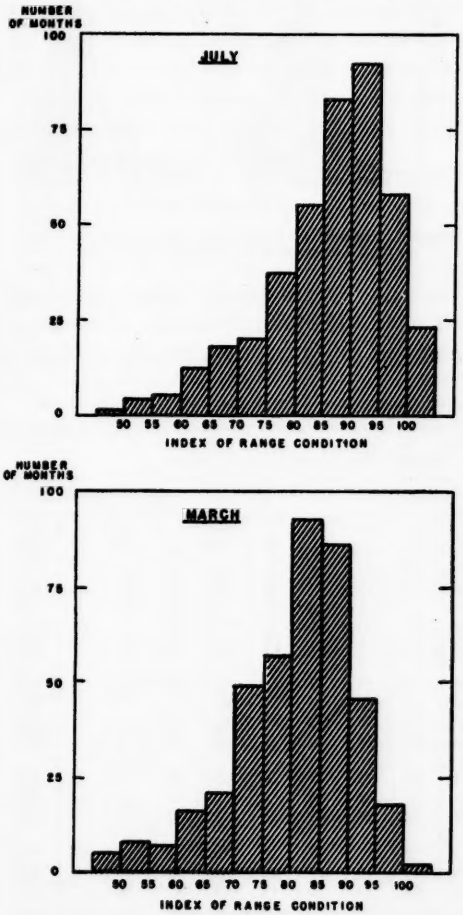


Figure 1. Frequency Distribution of Index of Range Condition, in 17 Western States Combined: 1923-1946.

Each state shows approximately the same skew distribution as the group of states, allowance being made for some irregularities and differences in modal points. This is illustrated by four states in Figure 2. Of those diagrammed, Oregon more nearly approaches a normal distribution than any other. There is a general tendency for the distribution in each state to be skewed in the same way and to about the same degree. The modal group was 90-94 in 1 state, 85-89 in 7 states, 80-84 in 8 states and 70-74 in 1 state. These differences in modal group do not tell the full story of differences in frequency distribution, because of some irregularities in distribution.

Median monthly indexes have been calculated for each month for each state, and are shown in Table III and Figure 3. These median monthly indexes vary relatively little from month to month. Six of the states had less than 7 percentage points difference between their lowest and highest monthly median; 7 had between 8 and 10, and only 4 had 11 or more points. In a Great Plains state such as South Dakota the ranges are more or less uniform throughout the state in their seasonal production of range forage. New grass begins to grow in late April or May and usually remains green until late summer. It gradually dries and remains dry, though cured on the stem, through the winter. The amount of feed produced, or even the amount available, varies greatly during the months of the year. In reporting a range condition index whose monthly medians vary relatively little, ranchers certainly could not

have meant the amount of feed produced or available by months. They applied some sort of normal seasonal standard and apparently reported deviations from it. In states where ranges have more definite seasonal limitations, as is true in all the mountain states, the monthly indexes may apply to different lands at different seasons. Thus, in Nevada, the index for July may apply to the higher mountain ranges and the index for January to desert winter range. This may account for some of the lack of seasonal variability in the monthly median indexes. However, even here ranchers apparently applied some sort of normal seasonal variation as a corrective factor.

While the seasonal variaton in monthly median indexes was far less than the variation in range forage production, there was nevertheless some seasonal variation, more or less regular. Ranchers applied a seasonal corrective factor which largely but not wholly eliminated seasonal changes in the median index.

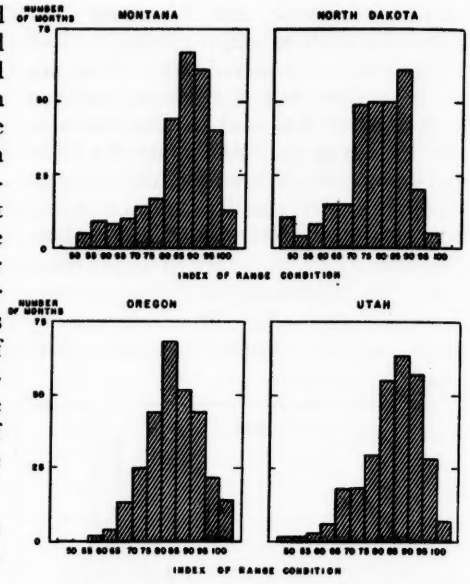


Figure 2. Frequency Distribution of Index of Range Condition, 4 Selected Western States: 1923-1946

In the Great Plains, Mountain, and Pacific Northwest states, the index rose in the late spring, usually reached a

TABLE II—Number of Months With Reported Range Condition in Each State: 1923–1946 Inclusive

Region	State	Number of Months with Given Index												
		–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99	100+	Total
Northern and Central Plains	Montana	.....	5	9	8	10	14	17	44	67	61	40	13	288
	N. Dakota	11	4	8	15	15	49	50	50	61	20	5	.....	288
	S. Dakota	20	2	1	8	10	29	26	59	76	36	19	2	288
	Nebraska	1	.....	4	10	15	16	25	48	83	64	18	4	288
	Kansas	22	21	12	6	22	23	28	42	58	38	13	3	288
	Colorado	1	8	.....	4	7	30	42	56	53	40	37	10	288
	Wyoming	2	5	2	5	12	27	29	67	66	47	17	9	288
Southwest and Southern Plains	Arizona	.....	.....	5	5	6	35	72	68	55	28	11	3	288
	New Mexico	2	4	9	4	5	12	48	85	80	27	12	.....	288
	Oklahoma	4	.....	5	22	43	58	55	48	38	15	.....	.....	288
	Texas	1	7	.....	3	10	36	60	72	60	30	8	.....	288
Pacific	Washington	.....	.....	1	1	14	27	47	64	63	50	19	2	288
	Oregon	.....	.....	2	4	13	25	44	68	52	44	22	14	288
	California	2	12	14	18	22	34	43	52	45	33	10	3	288
Mountain	Idaho	.....	1	3	7	12	18	29	55	70	52	31	10	288
	Nevada	.....	2	3	8	13	15	17	38	61	71	40	20	288
	Utah	2	2	3	6	18	18	29	55	63	57	28	7	288
Total		68	73	81	134	247	466	661	971	1051	713	330	100	4896

peak in July, and fell off by September to about its level before the spring rise. The rise from 80 to 85 (low "good") in early spring to 85 to 90 (high "good") by midsummer in the Plains states surely represents only a small fraction of the increase in feed availability and production. Cattle on the range in this area would be on a bare maintenance level in early spring but would be gaining a pound and a half or more daily by June. In the southern Plains and Southwest, there was a tendency for range condition to decline in midsummer and to recover in the fall. In California, the peak was in the spring. The peak conditions generally coincide with maximum seasonal forage production, the low conditions with least seasonal forage production.

Also noteworthy in Table III and Figure 3 are the differences in level of the index when the different states are compared. At the bottom is Oklahoma; the arithmetic mean of its twelve monthly medians is but 76.0 ("fair"). At the top is Nevada, with 88.2 ("good," almost "very good"). Should Oklahomans be considered pessimists because they rated the actual range condition so low? Or should they be rated as optimists because they considered normal so far above actual? Whether pessimists or optimists, why did they rate their range 12.2 percentage points below Nevada for the 24 years of record? It might be argued that these two rather remotely situated states had range conditions which averaged considerably different over these years. But North Dakota was at least 5 points below any neighboring or nearby state, and surely for a 24 year period its ranges were not this much below those of adjacent states. California was also relatively low.

A consideration of average changes in monthly medians leads to a consideration of the degree of uniformity of seasonal change from year to year. Tabulations were prepared, showing the number of years in which changes of given magni-

TABLE III—Median Monthly Index of Range Condition in Each State and for Each Month: 1923-1946 Inclusive

Region	State	Median Monthly Index												
		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year[1]
Northern and Central Plains	Montana	86.5	84.5	84.5	85.5	88	89.5	95	89.5	86	86.5	86.5	86.5	87.4
	N. Dakota	75.5	74	74	76.5	77	83.5	88.5	85	78.5	81	81	77.5	79.3
	S. Dakota	83.5	81.5	81.5	82	81.5	85 5	90.5	87.5	84	84	85	85.5	84.3
	Nebraska	84.5	84	84	85	86.5	88	91	88	88	88	85.5	85.5	86.3
	Kansas	77	79	80	81.5	82.5	85.5	85.5	79	81	79.5	81	79.5	80.9
	Colorado	82.5	81	81	83.5	84	86.5	85.5	87	85	82.5	84	82.5	83.8
	Wyoming	84	82.5	81	81	84	88.5	92.5	88.5	85	85	83.5	84	85.0
Southwest and Southern Plains	Arizona	79.5	80	81	82	82	80.5	78	79	83.5	82.5	80.5	80	80.7
	N. Mexico	83	82.5	83.5	83	81.5	84	80.5	81.5	83	86	86	85	83.3
	Oklahoma	70	70	73	75	79.5	85	85.5	77	74.5	77	74	72	76.0
	Texas	79	77.5	79	80.5	81.5	86	84.5	83.5	78	82.5	84	81	81.3
Pacific	Washington	84	83.5	82.5	81.5	85.5	87.5	90.5	85	81.5	81	78	82	83.5
	Oregon	83	81.5	82	85.5	86	90	89	87	80.5	80.5	80.5	81	83.9
	California	79.5	77.5	82.5	84	84.5	82.5	80.5	79	77.5	76.5	76	78.5	79.9
Mount'n	Idaho	84	86	87.5	87	85.5	87.5	90.5	88.5	84	83.5	82	80.5	85.5
	Nevada	88.5	87.5	88	88	88	92	90.5	88	84.5	84	87.5	88.5	88.2
	Utah	85	84.5	84.5	86.5	85	86.5	88	88.5	86	82.5	83	83	85.2
17 Western States[2]		79	79	79	80.5	84	85	86.5	83.5	81	82	82	80	81.8

1—Mean of 12 monthly medians.
2—Calculated from reported figures for 17 western states as a region, in same way as for each state; not an average calculated from figures in this table.

tude occurred from month to month for each state. The results are too detailed to be presented here in that form and, in any case, the frequency distributions are erratic because of the relatively small number of years in the available record. A simple summary has been prepared in Table IV. A great many changes in the index from month to month are relatively small, or are relatively small in relation to the change in median index. For the purposes of Table IV, changes of 3 points or less, compared to the change in median index, have been considered small. For most states and most pairs of months by far the greater part of the changes are less than this.

In the central and northern Great Plains, from half to three-fourths of the years show these relatively small changes in the fall and winter months. In the spring, however, and to a lesser extent in the summer, relatively greater changes are common. Thus, the change in the median index was shown in Figure 3 to be relatively small from late summer until the following spring; and the regularity of this relationship is fairly great. In the spring months, the median index rises; but there is great irregularity in this relation. In some years it rises greatly; in others, only slightly or even declines. Range condition in these states is greatly affected by climatic conditions in the spring and early summer; whatever the range condition which develops then, it will continue until the following spring with relatively small changes. However, occasionally large changes occur in these other months also.

A somewhat similar situation is found in other states. There appears to be a critical season in which the index changes most, on the average, and in which changes are least regular from year to year. In California, this season is late fall and winter. In that state the least change and the most regular change

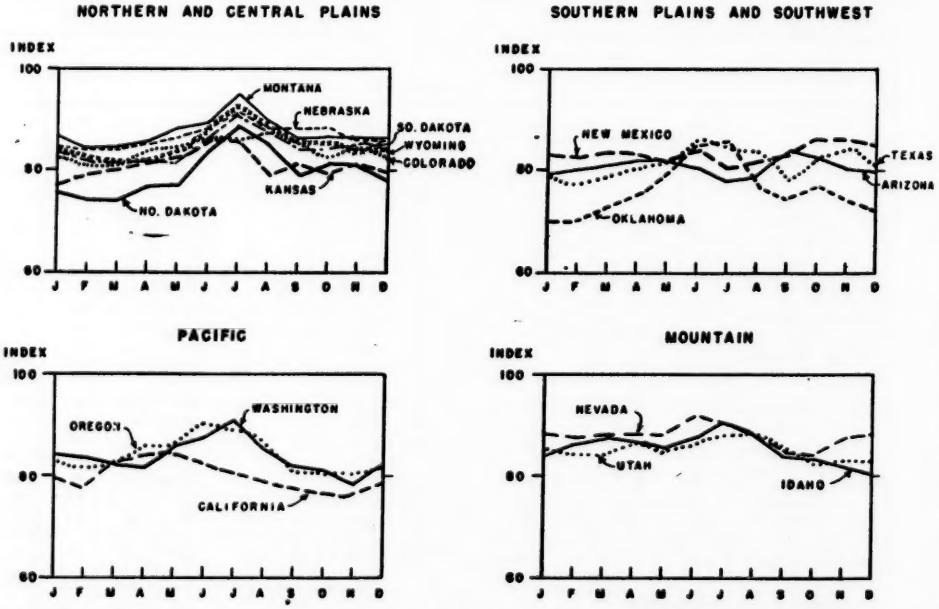


Figure 3. Median Monthly Index of Range Condition, by States and Regions: 1923-1946.

from month to month is from late spring to fall. Somewhat the same situation is found in Washington. Arizona shows the least regularity of change in late summer. Most other states have their period of least regularity in spring and early summer, but the exact timing varies somewhat.

Range Condition in Relation to Precipitation

The most obvious factor to check against range condition data is total annual precipitation. In the introduction to this article it was stated that the chief factor affecting forage production on range lands was the total available moisture supply. Experimental results indicate that precipitation not only in the current but also in the preceding year strongly affect range forage production. Accordingly, range condition has been correlated with total annual precipitation in the current and preceding years, with the results shown in Table V and Figure 4. This Table and Figure summarize data only from 1923 through 1941. When this analysis was first made the available data ended with 1941. These results have been presented previously.[3] As this article is written, state annual precipitation data for 1946 are not yet published. An analysis for the entire 1923-1945 period would be desirable, but the labor of recalculating all the correlations coefficients and other statistical measures exceeded the author's resources. Data for all states had previously been plotted on cross-section paper, and the 1942-1945 data were added. As far as could be determined by visual inspection, these data were fully in conformity with the earlier results. Accordingly, the results in Table V and Figure 4 are taken to be approximately the same as any that could be obtained by use of all available data.

The importance of total annual pre-

[3] Marion Clawson, "Range and Livestock Condition in Relation to Annual Precipitation," *American Cattle Producer* January 1944.

TABLE IV—Regularity of Change in Index of Range Condition, from Month to Month, by States: 1923–1946 Inclusive

Region	State	Percentage of Years in Which Change from Month to Month in Index of Range Condition Falls Within 3 Points of Change in Median[1]											
		Jan. Feb.	Feb. Mar.	Mar. April	April May	May June	June July	July Aug.	Aug. Sept.	Sept. Oct.	Oct. Nov.	Nov. Dec.	Dec. Jan.
Northern and Central Plains	Montana	83	79	88	42	46	50	46	79	46	83	75	79
	N. Dakota	58	71	46	42	38	38	46	33	67	83	71	79
	S. Dakota	46	75	71	29	33	50	67	67	75	83	75	79
	Nebraska	88	92	92	54	46	62	50	67	88	58	96	88
	Kansas	67	62	67	33	17	54	29	33	50	54	62	83
	Colorado	88	88	71	83	42	50	38	42	75	46	75	92
	Wyoming	88	71	75	50	38	42	50	100	75	67	92	83
Southwest and Southern Plains	Arizona	71	75	62	83	88	67	58	21	67	83	83	67
	N. Mexico	92	92	71	42	21	33	38	33	42	88	92	96
	Oklahoma	54	67	62	58	42	50	21	42	38	67	79	83
	Texas	54	62	54	58	33	54	67	46	42	75	79	88
Pacific	Washington	58	50	33	54	62	71	62	79	46	50	58	50
	Oregon	62	58	46	17	17	42	62	58	71	75	54	67
	California	54	42	38	33	75	92	88	100	100	79	12	38
Mountain	Idaho	75	50	50	33	46	46	71	71	58	58	29	42
	Nevada	71	67	50	50	25	38	42	50	71	38	50	71
	Utah	54	67	71	38	42	33	38	46	58	71	71	58
17 Western States		96	88	88	62	75	54	88	83	83	100	96	100

1—Three whole points on either side of whole point change in which change in median lies, or three whole points on either side of dividing line on which change in median lies.

TABLE V—Range Condition as Related to Annual Precipitation in Current and Preceding Years, 17 States Wholly or Partly in Range Livestock Region: 1923–41[1]

Region	State	Average Annual Precipitation 1923–41	Average Range Condition 1923–41	Estimate of Range Condition on Basis of Precipitation in Current Year			Estimate of Range Condition on Basis of Precipitation in Current and Preceding Years		
				Formula[2]	R^2[3]	S	Formula[2]	R^2[3]	S
Northern and Central Plains	Montana	14.29	84.5	$Y=48.5+2.52\ X_1$	.70	7.2	$Y=22.7+2.38\ X_1+1.96\ X_2$	.87	5.3
	North Dakota	16.03	75.7	$Y=46.2+1.84\ X_1$	.70	6.5	$Y=21.1+1.82\ X_1+1.61\ X_2$	.89	4.4
	South Dakota[4]	16.64	78.4	$Y=47.7+1.84\ X_1$	.71	7.7	$Y=31.7+1.59\ X_1+1.21\ X_2$	.85	6.1
	Nebraska[4]	17.45	83.5	$Y=56.6+1.54\ X_1$	.71	5.9	$Y=35.4+1.62\ X_1+1.14\ X_2$	.87	4.3
	Kansas[4]	18.22	73.5	$Y=38.1+1.94\ X_1$	.65	12.0	$Y=\ 8.9+1.79\ X_1+1.82\ X_2$	.83	9.2
	Colorado	16.47	83.3	$Y=53.7+1.20\ X_1$	.52	8.2	$Y=15.8+2.03\ X_1+2.15\ X_2$	.85	5.4
	Wyoming	14.28	82.7	$Y=48.9+2.37\ X_1$	.68	6.3	$Y=20.6+2.23\ X_1+2.15\ X_2$	.89	4.1
Southwest and Southern Plains	Arizona	14.36	81.5	$Y=64.3+1.20\ X_1$	.77	3.2	$Y=57.3+1.16\ X_1+\ .54\ X_2$	.83	3.0
	New Mexico	15.43	81.4	$Y=70.7+\ .70\ X_1$	.41	5.5	$Y=45.0+\ .78\ X_1+1.68\ X_2$	.80	3.8
	Oklahoma	33.39	74.3	$Y=50.7+\ .70\ X_1$	.76	3.8	$Y=41.8+\ .70\ X_1+\ .28\ X_2$	.80	3.7
	Texas	30.80	80.3	$Y=64.6+\ .51\ X_1$	.41	6.2	$Y=45.1+\ .53\ X_1+\ .63\ X_2$	.59	5.8
Pacific	Washington[5]	16.51	83.7	$Y=69.8+\ .84\ X_1$	.58	4.4	$Y=64.0+\ .82\ X_1+\ .38\ X_2$	.64	4.4
	Oregon[5]	13.91	84.3	$Y=71.8+\ .90\ X_1$	.40	5.6	$Y=68.4+\ .88\ X_1+\ .27\ X_2$	.42	5.9
	California	22.76	77.5	$Y=63.4+\ .62\ X_1$	.38	10.3	$Y=53.3+\ .50\ X_1+\ .57\ X_2$	.49	10.3
Mountain	Idaho	17.61	84.6	$Y=68.1+\ .94\ X_1$	.49	5.4	$Y=72.7+\ .92\ X_1-\ .24\ X_2$	.51	5.7
	Nevada	8.52	86.1	$Y=65.8+2.38\ X_1$	.74	4.8	$Y=64.2+2.32\ X_1+\ .26\ X_2$	.75	5.0
	Utah	13.50	83.9	$Y=59.6+1.80\ X_1$	.75	4.7	$Y=48.3+1.76\ X_1+\ .90\ X_2$	.80	4.4

1—When this Table was first constructed, data through 1941 only were available. Plotting of data for later years on the work charts seemed to indicate that extra labor of recalculation through 1946 was not worth-while.
2—Y is annual average range condition, X_1 is annual precipitation in current years, and X_2 is annual precipitation in preceding year.
3—Uncorrected for number of years in record.
4—Western part of state.
5—Precipitation of eastern part of state, range condition for state as a whole.

cipitation to range condition is obvious, and particularly striking in the Great Plains. For the seven states here included in this region, the correlation ratio (uncorrected for number of observations) between precipitation in the current year and range conditions run from .52 in Colorado to .71 in South Dakota and Nebraska. Except for Colorado, every state had a ratio of .68 to .71—extremely similar. This similarity is still further increased when precipitation in the preceding year is added. R (also uncorrected for number of observations) now ranges fron .83 to .89. Squaring the coefficient of correlation to obtain the coefficient of determination shows that the latter is increased approximately 50 percent by adding precipitation of the preceding year as an independent variable. This uniformity in results from state to state, plus substantial concurrence in the following four years, seems to indicate considerable significance for the results obtained.

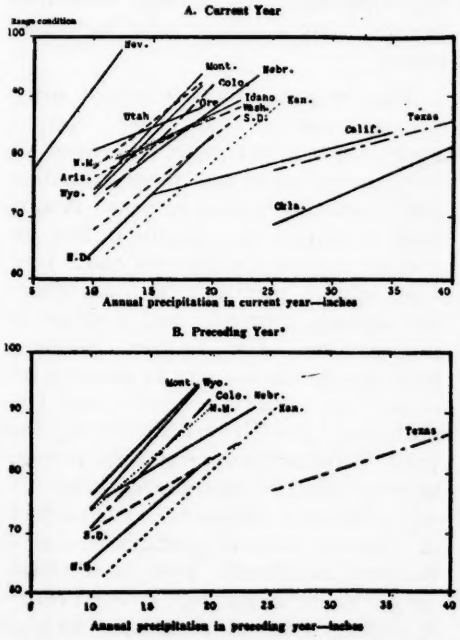


Figure 4. Net Relationship of Range Condition to Annual Precipitation in Current and Preceding Year,[1] 17 Western States: 1923-1941.

[1] Precipitation in other year at average level.
* Only those states are shown in which there was a significant relation between precipitation in the preceding year and range condition in the current year.

In these seven states average annual precipitation does not diverge too greatly, so that the regression coefficients are also similar. An extra inch of precipitation increases range condition in the same year by 1.2 to 2.5 points; in all except Colorado by 1.5 to 2.5 points. The addition of precipitation in the preceding year gives the *net* effect of precipitation in the current year; the effect of an inch of precipitation now ranges from 1.6 to 2.4 points of range condition. Colorado and, to a lesser extent, Montana, have now been brought into closer conformity with the other states. The influence of an inch of precipitation in the preceding year varies from 1.1 to 2.2 points of range condition. The average net influence of an inch of precipitation in these seven states is 1.9 points of range condition in the current year and 1.7 points in the following year. Inspection of the charts for individual states shows that the influence of precipitation in the preceding year is marked if it deviated far from average; that is, range condition tends to be low following a year of drouth or high following a relatively wet year. Precipitation varying closely around average has less noticeable effect upon range condition in following years.

It was previously pointed out that range condition tends to change slowly in the northern Plains from fall until the following spring. The average range condition index for a year is thus partly influenced by this relative constancy of a level of range condition established in the preceding year. One reviewer of the previous article on this subject characterized the influence of precipitation in the preceding year as "statistical," implying

lack of real significance. Such a view is erroneous, for two reasons: (1) if range condition reflects amount of forage available in comparison with normal seasonal conditions, as the present analysis suggests, then the amount of feed available during the dormant months, January-March, is actually determined by precipitation in the preceding year, except as grazing has consumed it; and (2) the influence of precipitation in the preceding year is too great, statistically, to be explained in this way. It seems clear that forage growth during the growing months is affected by precipitation in the preceding year.

Results in the other ten states do not fall into such neat patterns as those in the northern Plains. In three states—Oregon, California, and Idaho—the correlation coefficient, when either precipitation for the current year only or for it and for the preceding year are included as independent variables, is about on the borderline of significance. In Texas the relation is but little better. Except possibly in Texas, precipitation in the preceding year is without significant influence. In New Mexico, precipitation in the preceding year is apparently more important than in the current year; the effect upon the correlation coefficient is greater and the regression coefficient is larger. In the other five states—Arizona, Oklahoma, Washington, Nevada, and Utah—the influence of precipitation in the preceding year is not significant. The correlation between precipitation in the current year and range condition is from .74 to .77 in each state except Washington, where it is much lower.

The results presented so far in this section seem to show a high degree of consistency in farmers' and ranchers' reports of range condition. This is more evident when one recalls the precipitation record of the 1923-1941 period. From 1923 to about 1930, precipitation was approximately normal, with some year-to-year variations. Then ensued roughly a decade of seriously subnormal precipitation, worse in some years than in others. Ranchers had a certain scale of values in mind in reporting range condition in the earlier years. The successive drouths might easily have caused them to waver in their judgment, and to establish a new subjective scale of values. Had they done so, range condition in the later years would have been reported differently, even though actually identical with conditions in some earlier year. The relatively close relation between precipitation and range condition, which was as close in later as in earlier years, seems to show that the subjective standards of range evaluation remain fairly constant over the entire period.

The foregoing analysis almost surely underestimates, rather than overestimates, the true net relation between annual precipitation and range condition. This is true for several reasons. Annual range condition may obscure or blur important variations within the year. Likewise, annual precipitation data ignores the seasonal shortages and surpluses of precipitation. For instance, relatively large precipitation might be received late in the year, whose effect upon range condition would be felt very little during that year. More seriously, statewide averages of range condition and precipitation conceal important variations. The problem of "border" states is especially serious, as has been mentioned. Few states contain only a single forage type or even ranges of uniform seasonal usefulness. In some states the statewide average annual precipitation includes data from large essentially non-range areas, some of which may dominate the precipitation figures. In California, for example, precipitation

data for the state as a whole are strongly influenced by coastal areas, which are much less important range areas than are the foothills. This problem was met in part by use of precipitation data for the western or eastern halves of some states. If range condition data could be analyzed for significant natural areas and if suitable precipitation indexes truly representative of those areas were available, one would logically expect substantially closer results than presented previously. Substantial amounts of work would probably be involved in such calculations.

Other climatic factors and natural factors other than climatic logically may exert some influence on range condition. No attempt has been made in the present study to measure them. Any such attempt would probably be more successful after the previously described refinements in studying the influence of annual precipitation had been made. One important factor may be seasonal distribution of precipitation. A suggestion for handling this is given later. The influence of temperature may be significant—frost, unusually cold weather during the early growing season, abnormally high temperatures at other seasons, etc. The effect of grasshopper, insect, or other infestations might be significant in some areas.

Perhaps the most fruitful line of further analysis is to study the effect of precipitation and temperature upon the month-to-month changes in range condition at the critical seasons revealed in Table IV. Range condition may change several points in either direction from April through August in the northern Plains, for instance. Are these changes related to variations in current-monthly precipitation? Or to variations in current temperatures? Or to variations in past precipitation? In California, range forage growth in the foothills depends on the timing of fall rains and upon subsequent temperatures. Early rains followed by mild or relatively warm weather means greater forage growth than if there is little rain or if temperatures are low. A range-condition index for this area might be highly correlated with precipitation and temperature data for the same area. By concentrating on the months in which changes in range condition largely occur, one might largely identify the factors causing those changes and eliminate climatic or other factors of little or no influence.[4]

The analysis in this section does not touch directly upon the frequently disputed question of the proper rate of stocking of ranges. Within fairly wide limits of stocking, forage production will respond to variations in climatic conditions without much or any regard for the rate of stocking. The long-run proper rate of stocking must, of course, be based upon normal precipitation and to that extent the foregoing analysis may have some bearing upon the question of the proper rate of stocking. But for the most part this question must be decided upon other grounds.

Range Conditions in Relation to Livestock Condition

As pointed out earlier, the same mailed inquiry which obtains estimates of range condition from farmers and ranchers also obtains estimates of the "condition" of "all cattle and calves" and of "all sheep and lambs." Space does not permit a full analysis of these latter data, but their relation to range condition data can be stated briefly.

The month-to-month and annual aver-

[4] The types of analyses suggested here would provide excellent subjects for research by graduate students in agricultural colleges of the western states. In addition to the lines suggested here, the analysis might be extended to a consideration of the variation in individual reports, if these are available for analysis. By including large or small areas, the size of the research problem could be adjusted to the resources available.

age figures on condition of cattle and calves and of sheep and lambs are closely correlated with range condition. Tables comparable to Table V were not constructed, due to the labor involved, but approximate calculations based on scatter diagrams indicate that the correlation between range and livestock condition exceeds .8 in each state. This was true even in those states where range condition was not highly correlated with annual precipitation. There was a noticeable lag of livestock condition behind range condition when the latter declined. This lag varies from nothing to 3 or 4 months. When range condition improved, on the other hand, livestock condition improved promptly and with no apparent lag. If this fact were recognized in the formula of relationship between the two indexes, the correlation coefficient would be increased further.

The indexes of livestock condition average somewhat above the index of range condition, by an amount which varied somewhat from state to state. This is true when all three indexes are at a fairly high level, and becomes more noticeable as they fall to a lower level. The relation between the indexes of livestock condition and the index of range condition is not one to one; instead, the indexes of livestock condition mostly move from one-half to two-thirds of a point for each one point change in range condition.

The indexes of condition of all cattle and calves and of all sheep and lambs, in the states where both are reported, are much more closely correlated with each other than is either with range condition. In fact, for many months the livestock indexes are identical in many states, or the change from month to month is the same for each.

A complete analysis of the available data on livestock condition would include a study of its relation to such livestock production rates as calf crop, death loss, weight per head of animals of given age marketed, pounds of meat produced per head in the breeding herd or flock, wool per head, etc. This was not done in the present study, because of the work involved.[5]

Usefulness of the Foregoing Analysis

What is the economic significance of the foregoing analysis? On the basis of the analysis presented in this article, it appears that the range condition figures are a fairly reliable index as to the volume of range forage produced. Extensive measurements of the volume of actual range forage growth would be required to substantiate this conclusion fully. But the internal consistency of the range condition data and their relation to other data lend substantial support to this hypothesis. If range condition figures can be used as an index of the volume of range forage production, an important new agricultural statistic is available. The volume of range forage production is greater than is generally realized. It has been estimated that half or more of the total feed required by all livestock in the eleven Western States comes from range.[6] Substantial additional amounts of range forage are produced in the tier of states from North Dakota to Texas also. In all, the equivalent of roughly 40 to 50 million tons of hay are produced annually on the range lands of the West, or a production roughly half that of all harvested hay in the United States. The importance of range forage is particularly great in some states. Variations in range forage production are not included

[5] Harold R. Hochmuth in a letter to the author, dated September 19, 1947, states that analyses of this type are under way by the Bureau of Agricultural Economics.

[6] H. E. Selby and Donald T. Griffith, *Livestock Production in Relation to Land Uses and Irrigation in the Eleven Western States*, Bureau of Agricultural Economics, Berkeley, California 1946 (processed).

in any production or income figures, except indirectly through their influence on livestock production. Use of range condition figures as an index to the volume of forage produced provides us with an agricultural production statistic which can be used in any way that production statistics on cultivated crops can be used.

Any use of range condition as a measure of range forage production must consider the seasonal and state-to-state variations in the index. Unadjusted range condition figures might lead to erroneous conclusions.

The analysis in this article emphasizes the dominant influence of total available moisture upon the range areas. Given enough rain and other moisture, range forage production will be relatively high; in the absence of moisture, growth is necessarily scanty. Over-grazed, properly grazed, and under-grazed range all react to more moisture in the same way—by producing more feed. Their reaction is unlikely to be equal, for extensive studies and observation have shown that over-grazed range is limited in its ability to take advantage of favorable moisture conditions. But in the dry range region more moisture means more feed. The overwhelming importance of this fact plus the truly enormous variations in range forage production from year to year combine to create the active interest in precipitation, that amounts almost to an obsession, in the range region.

The analysis in this article provides an accurate method of forecasting forage production, within certain limits, for a period several months ahead, for about half of the West. In approximately half of the states, range condition any year is influenced about as much by precipitation in the preceding as in the current year. This was especially noticeable in the central and northern Great Plains. By September annual precipitation for any year is fairly well known. Range condition the following year will be strongly influenced by that date. Ample or scanty rain the following year will affect range condition, but from the level established by precipitation conditions of the first year. Cattle marketing in the fall can take account of precipitation in that year and thus of probable range condition the following year. For instance, if some year has been average or drier, only unusually favorable moisture the following year will produce above-average range. If cattle numbers are unusually high, there is a serious gamble involved in failing to reduce them to at least average levels. On the other hand, if precipitation has been high some year, range condition the following year will be above average even if rainfall is only average. The gamble involved in holding more than average numbers of cattle is reduced, though not eliminated.

These indications of range condition in the following year are only indications, not certainties. Unusual precipitation in the following year may completely reverse the indication, but this is unlikely. The shortage of range forage associated with extreme drouth is hardly possible following a wet year. The most severe drouths which resulted in losses of livestock and income have come after subnormal moisture and range conditions.

These possibilities of estimating range condition some months ahead facilitate greatly the problems of adjustment to the broad swings ("cycles") in annual precipitation. In approximately one-third of the West there is a marked tendency for years of high and of low annual precipitation to occur in sequence.[7] In these areas it is probably psychologically impossible for ranchers to operate on the

[7] Marion Clawson, "Sequence in Variation of Annual Precipitation in the Western United States," *Journal of Land & Public Utility Economics*, August 1947.

basis of constant livestock numbers, and uneconomic as well. The real problem is to avoid over-expansion in wet periods and to contract quickly enough when average or dry years occur. The area in which occurs this tendency to sequences of wet and dry years is to a large extent the area in which the influence of precipitation in the preceding year is greatest. At least the northern Great Plains fall in both groupings; other areas mostly do not fall in both categories. In the Great Plains particularly, a range livestock management program should be based upon the known tendencies in variability of annual precipitation and upon the facts as to the influence of annual precipitation upon range condition. By so doing, the heavy losses of 1934 can be avoided partially in the future.

Price Discrimination in Space Heating

By EMERY TROXEL*

THE gas industry which was building transmission lines in the thirties well beyond its sales at the prevailing prices needed new outlets for services. One of these new outlets was space heating—heating of homes, office buildings, and industrial plants of which the largest and most expansive was residential heating. Neither the commissions nor consumer groups nor even sales-minded managers of the companies seemed to recognize the discriminatory pricing by which substitution of gas for coal and fuel oil was sought. Seeing the new business as a fine piece of "promotional" selling and pricing, the managers and regulators did not recognize evidence of discriminatory pricing when gas prices were adjusted to prices of the alternative fuels—when approximate price elasticities of demand clearly controlled the choices of heating prices. Meanwhile, these sales of gas expanded so rapidly that pipe lines were strained to the full limits of their capacities, and distribution companies were forced to deny service to new buyers and to limit sales sometimes to old customers.[1]

Among commissions, cities, and space-heating customers the popular solution of the problem is construction of more pipe lines. These interests, as well as the gas companies at present, do not say anything about price revisions that can be used to control heating sales relative to plant capacity or the costs of plant expansion. This article gives primary attention, however, to the pricing side of the problem—to the general nature and possible alterations of discriminatory pricing. First, discrimination in the original heating prices is examined. Next, the demand changes in the heating market, including the effects of coal and oil-price changes on gas demand, are described. Third, several possible policies for price revisions are considered in connection with demand and cost changes. Finally, attention is given to commission opinions on gas shortages, and possible shifts of additional investment costs away from heating customers.

I

Discriminatory prices for space-heating, appearing largely in the thirties and being maintained in their original or slightly revised form to the present time, are a basic condition of the economic reasoning in this article. Such a condition, so far removed from familiar business and commission thought about price differences, needs brief explanation. The general idea and some evidence of price discrimination for space heating are sketched here. By price discrimination I mean, as most economists do, that price differences are controlled partly or altogether by demand differences between buyers or buyer groups rather than by

* Associate Professor of Economics, Wayne University.

[1] This article does not deal with industrial gas service—particularly the interruptible service. Reserving the right to cut off industrial service on a 24-hour or some other short notice, gas companies improved their load factors and increased their earnings. Considered temporary business that would be dropped altogether as other sales increased, interruptible service persisted in the thirties, became regular and non-interruptible business under government requirements of the war period, and was not reduced sharply after the war. Then the interruptible contracts began to create their own sort of seasonal unemployment, and the situation in some midwestern manufacturing centers suggested the desirability of fewer interruptible and more regular (higher-priced) contracts for industrial buyers rather than moderate private economies at considerable social costs. In fact, interruptible service may not be subject to elimination or interruption after it persists for several decades or more, and becomes important to manufacturers and communities. Cf., *Re Southern Counties G. Co.* (Cal.), 51 P.U.R. (N.S.) 125. 127 (1943).

cost differences alone.[2] Prices are differentiated according to price elasticities of demand, and are controlled consequently by marginal revenue changes wherever the seller controls the market for his commodity, can classify buyers, and does not expect commodity transfers between low-price and high-price buyers. But discriminatory pricing is not something completely disassociated from production costs; it is limited by the marginal or incremental costs of service production. Indeed, it is simply a special case of monopoly pricing, and conforms to the familiar generalized rule of marginal revenue = marginal cost.

Parenthetically: some economists, thinking clearly of discriminatory pricing as a special case of monopoly pricing that further maximizes profits over a uniform monopoly price, also define price discrimination as a case where the prices are not proportionate to their respective marginal costs. That is, when $\frac{P_1}{MC} = \frac{P_2}{MC_n}$ the pricing is discriminatory by this definition. This definition does not cover the discrimination case in which there are no marginal costs. Otherwise, this meaning for price discrimination is equivalent to the one used above when, as is essential in a profit-maximizing concept of price discrimination, marginal cost is assumed to be equal to marginal revenue. It can be reduced simply to price differentiation relative to the slopes of the marginal revenue curves—to demand elasticities. It is another way of saying that monopolistic, profit-maximizing discrimination is not simply or even necessarily a case of price differences.

In the simplest case of discriminatory pricing the seller does not have any variable or marginal costs of production, and is concerned altogether with price elasticities of demand. If the firm seeks the maximum revenue advantage of its position, he fixes the price for each buyer group where the marginal revenue of the group equals zero. That is, $MR_1 = MR_2 = \ldots MR_n = O$ where MR_1, MR_2, . . . MR_n are the marginal revenues of the several buyer groups.

In the next case, a common one among economists who follow the analysis of Joan Robinson, the company has marginal costs of production that are assumed to be the same for all buyer classes. To maximize profits in this situation, the firm differentiates prices so that the marginal revenues of the several classes are equal to the uniform marginal cost. This is a case where $MR_1 = MR_2 = \ldots MR_n = MC$.

To have a more realistic presentation of the discriminatory-pricing idea, we should allow for probable differences in both marginal costs and demand elasticities between buyer classes. Then each class has a separate equation of marginal revenue and marginal cost, though the demand elasticities continue through the marginal revenues to influence the price differentiation. Here the generalized equation is: $MR_1 = MC_1$, $MR_2 = MC_2$, . . . $MR_n = MC_n$.

The concept or idea of price discrimination does not show, as defined and described above, that space-heating rates are examples of discriminatory pricing. A conclusive showing or, what is more nearly the nature of knowledge in this article, a reasonable suggestion of discrimination depends on evidence of demand differences and managerial action. It depends on evidence that, as prices were chosen, gas companies were guided

[2] For futher discussion of the idea and economic conditions of price discrimination see: Joan Robinson, *Economics of Imperfect Competition* (London: the Macmillan Co., 1933), pp. 179-188; H. E. Batson, *The Price Policies for German Public Utility Undertakings* (London: Oxford University Press, 1933), pp. 75-76; Kenneth E. Boulding, *Economic Analysis* (New York: Harper & Brothers, 1941), pp. 540-549; *Economics of Public Utilities* (New York: Rinehart, 1947), pp. 78-593, 619-644.

by price elasticities of demand. In the thirties their knowledge of demand conditions doubtless was imperfect, and could not be reduced to an exact and extensive demand schedule such as an economist often assumes for the sake of easy description. Nothing so explicit, nothing with so much price and quantity range as the familiar demand curve of an economist was really used. At best the price discrimination was technically imperfect. Yet the managers, looking to additional profits, seemed to show an awareness that the heating demand was more elastic than the general household or small-scale commercial demand.

Price elasticities of demand were different between classes of gas consumers because substitutes were more available and acceptable to one class than to others. Coal and fuel oil were direct and effective substitutes for gas heating, whereas electricity was the only immediate substitute for most other household uses of gas. In fact, gas companies in the new space-heating markets were forced to adjust their prices downward, even sharply downward if they wanted to attract numerous installations of gas furnaces. On the other hand, a reduction of the rates for cooking and water-heating uses probably would have been followed by slight changes or no changes at all in sales; the demand for general domestic service seemed to be quite inelastic.[3] Entering into competition with coal and fuel oil and seeking sizable sales, the managers recognized a high substitutability between the fuels and they fixed their prices accordingly. At any rate the managerial awareness of demand differences seems to be indicated by the fact that the old services were taken for granted and given only small price reductions, while prices were reduced substantially to attract sales and to obtain additional revenue from the new market for heating.

Whatever the specific evidence on price elasticities of demand may be, managers and sometimes commissioners may emphasize a cost determination of heating rates. A favorite argument emphasizes the low marginal costs at which heating sales were first made. (Either "additional" or "increment" cost is likely to be their terminology, but in the large sense the meaning is the same as marginal cost.) Certainly the transmission and distribution companies commonly experienced low marginal (additional) costs as they used "extra" capacity—as they measured increments in total cost with a given plant. But these facts do not prove that the additions to total cost were peculiarly low for space heating. Under the prevailing conditions the marginal costs were likely to be low for any sort of service. Indeed, if additional service were produced for cooking customers alone (whether families wanted more cooking gas was not pertinent!),[4] the increments in total cost probably would have been as low or nearly as low as they were for space heating.

As a further fact, any guidance by marginal costs, either in the sense of a large cost increment or in the more refined sense of the economist's meaning, is suggestive of monopoly pricing. Marginal costs, as noted above, are associated with discriminatory pricing. They fix economic limits of such pricing. Given the price elasticity of demand for a buyer group, the class price varies directly with the marginal costs of production. In so far as space-heating rates are associated with high elasticities of de-

[3] Having time to become attached to the "superiority" of gas and possessing specialized equipment, space-heating buyers doubtless have less elastic demand now for service than they once did. A new class of buyers often passes from an elastic to a less elastic or even an inelastic demand for service.

[4] Let it be a case of free service and careless consumption because the measurements obviously concern production costs rather than revenues and prices.

mand and marginal costs—and apparently they are—there is evidence of discriminatory pricing.

II

While the prices of space-heating gas remained fixed or changed only slightly, several kinds of demand changes occurred in this market during the late thirties and the forties. Some were demand increases that were associated with extraordinary changes in family incomes, or were results of architectural trends and a growing prefabrication of houses and their equipment. Others were unfolding demand responses to gas-heating service that meant increasing elasticities of demand in the lower price ranges. Finally, as a notable fact in public utility regulation, the lower parts primarily of the demand schedules shifted to the right as coal and fuel oil prices increased; if plant capacity were available (and it soon was not available in most cities), the companies could sell increasing quantities at fixed prices. These changes are significant because each one suggests some possibility of a managed or regulated price revision: a change in demand elasticity alone is enough to justify a revision of discriminatory pricing and an increase in demand, associated with increasing or decreasing costs, is the reason for a further price change. But managers and commissioners, quite attentive to initial demand conditions, reverted apparently to an easy indifference to demand elasticities and other demand behavior, and were content with a large expansion of sales.

The general shape of the demand curve for gas heating is a preliminary problem. Shall the choice, as a matter of generalized relationship, be some sort of oligopolistic demand curve that allows for reactions from rival sellers as gas-heating prices change relative to other fuel prices, or shall the choice be a Marshallian-type curve with which the prices of other commodities are assumed to be fixed? The oligopoly curve may provide for reactions of one sort or another to both increases and decreases in gas-heating rates, or it may be "kinked" at the current price relationship in such a way that gas-company managers anticipate reactions, for instance, to price reductions but not to price increases.[5] And the Marshallian-type curve for a commodity can follow tradition strictly and be based on fixed prices of all other goods and services, or as a matter of a larger realism it can be based on fixed prices for only close substitutes.

Price reactions among rival sellers do not seem to be significant in the heating market. Even though there are only a few sellers of other fuels (particularly of oil) in many markets, the price reactions to changes in gas prices are not common —at least not common knowledge. In the thirties the coal mining and retailing interests did much political and other protesting against gas-heating service and prices, but they were not sufficiently disturbed to engage in retaliatory price cutting. Perhaps the sellers of coal wanted to reduce their prices in the heating market; but price differentiation was not as easily managed as in the gas industry, and general price reductions meant a considerable loss of revenue and earnings in other and less competitive markets. In any case the prices of fuels did not move together during the past fifteen years; the prices of coal and fuel

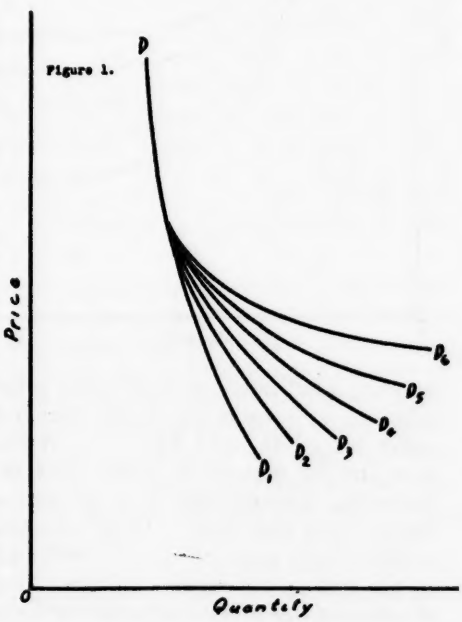
[5] For discussion of "kinked" demand curves see: R. L. Hall and C. J. Hitch, "Price Theory and Business Behavior," *Oxford Economic Papers*, No. 2, May 1939, pp. 22-25; Paul M. Sweezy, "Demand under Conditions of Oligopoly," *Journal of Political Economy*, Aug. 1939, pp. 568-573; M. Bronfenbrenner, "Applications of the Discontinuous Oligopoly Demand Curve," *Journal of Political Economy*, June 1940, pp. 420-427; Clarence W. Efroymson, "A Note on Kinked Demand Curves," *American Economic Review*, Mar. 1943, pp. 98-109.

oil, affected directly by wage and transportation costs and in general by demand conditions, increased continuously while gas prices for space-heating remained quite stationary. These experiences suggest a good deal of independency in the actual price relations between gas and other fuels, even though the substitutability between them is high. Consequently, a Marshallian-type curve closely approximates the demand condition for space-heating gas. Here a demand curve for this gas service is based on the assumption that the prices of alternative fuels are fixed.

Gas companies have experienced substantial demand increases in the space-heating market. Some of these increases have been associated with wartime and postwar additions to family incomes. Considering gas the superior form of residential heat, families naturally can better afford to buy new furnaces and even pay higher fuel bills (though postwar increases in oil and coal prices makes gas the cheapest source of heat in some localities) if their incomes increase. Furthermore, the recent popularity of the one-story, no-basement, and supposedly "functional" house contributes to the increases in gas demand; architects more frequently specify gas or oil heat than they once did.[6] Radiant-heating systems can accentuate this trend away from coal heat. And prefabrication of "utility" units, consisting of heating equipment and kitchen appliances and possibly a bathroom, can be a further influence in the same direction. These several kinds of demand increases, taken a part from increases in coal and fuel oil prices, probably are sufficient alone to strain pipeline and distribution-system capacity in many areas.

Another sort of demand change is the gradual response of buyers to the new gas-heating service. If family incomes, prices of alternative fuels, and architectural patterns are fixed, gas companies still must wait five or ten years or even a longer time for a full reaction to most price choices. Buyers need time to consider a change-over to a new fuel, recognize obsolescence in installed equipment, and make plans to finance the new appliance investments. This demand condition is illustrated in Figure 1 where DD_1 is the initial prospect of demand, and DD_6 is the eventual or full response under "given "conditions. Managers doubtless made allowances for such gradual responses as they chose the original heating rates. But they scarcely knew exactly how much price elasticity of demand could be realized, and consequently should have considered a revision of dis-

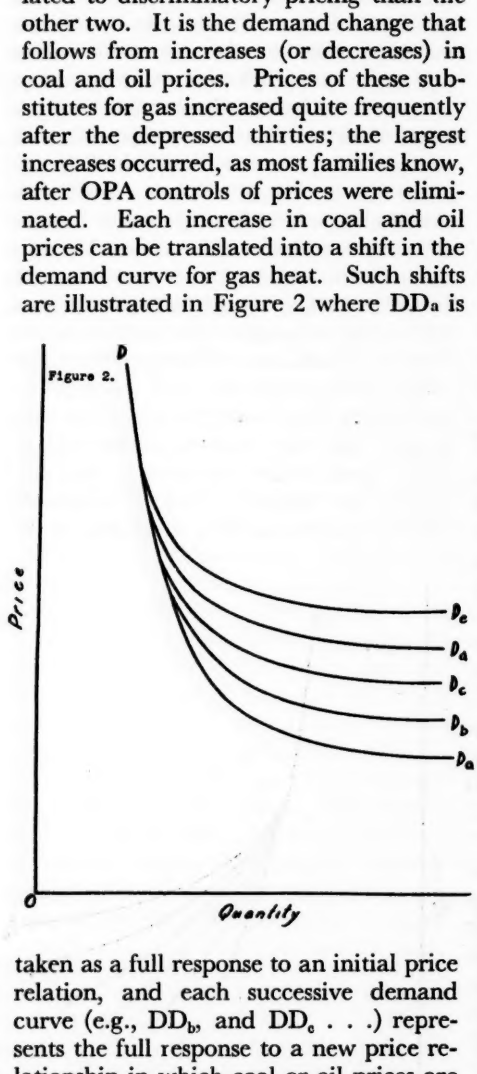
Figure 1.



[6] Simplified and nicely-controlled heating certainly is in accord with "functional" construction, but neglect of future oil and gas supplies is something else. Guided simply by what is available in heating means, "modern" home architecture gets in the way of its own efficiency ends and requires, as a minimum, a re-examination of available means.

criminatory pricing as the demand stabilized around DD_6.

A third kind of demand change for space-heating service is more directly related to discriminatory pricing than the other two. It is the demand change that follows from increases (or decreases) in coal and oil prices. Prices of these substitutes for gas increased quite frequently after the depressed thirties; the largest increases occurred, as most families know, after OPA controls of prices were eliminated. Each increase in coal and oil prices can be translated into a shift in the demand curve for gas heat. Such shifts are illustrated in Figure 2 where DD_a is



taken as a full response to an initial price relation, and each successive demand curve (e.g., DD_b, and DD_c . . .) represents the full response to a new price relationship in which coal or oil prices are higher than they were. These changes, as illustrated, probably are concentrated in the lower price range—the price area of common substitution between the fuels. And they indicate, of course, that larger quantities of gas can be sold for space heating as prices of the alternative increase—that sales managers of gas companies cannot take credit for some considerable part of the recent demand changes. Changes in the prices of substitutes are important facts in discriminatory pricing, and we shall return to them in the next section.

An interdependency of fuel prices can be described technically in terms of cross elasticity of demand. A significant cross elasticity of demand is evident between gas and other fuels, i.e., the relative change in gas sales divided by the coal-oil prices is substantial. And such a cross elasticity of demand, measuring the rate of substitution of gas for coal or oil, probably is higher with house owners than with landlords, varies with prospects of future fuel supplies, is likely to be highest among high-income families, and is affected by the size of the price change as well as anticipated price changes. Furthermore, the substitution of gas for other fuels probably is not reversible at the same rate, i.e., after families change to gas and become attached to the "superior" fuel, they are likely to resist quite strongly a shift back to an "inferior" fuel even if prices of the alternatives decrease sharply.

III

This section deals with possible pricing policies in the gas-heating market. Starting with discriminatory pricing in which gas prices were adjusted to the prices of coal and oil, gas-distribution companies did not adjust their prices upward as the prices of alternative fuels increased. Estimating eventual additions to their sales at chosen prices, they did not make price adjustments as buyer responses were experienced; they did not make corrections to experienced demand elasticities. Seek-

ing sales originally with low increment (marginal) costs, the natural gas industry did not alter prices when increases in sales pressed on plant capacity and increments in total cost became associated with additional plant investments. Prices were not adjusted to changes in marginal revenues and marginal costs as a minimum pattern of discriminatory pricing was not consistently maintained.

One policy for pricing adjustments is simple: increase or decrease gas-heating rates in proportion to the change in coal and oil prices.[7] This can be done with fuel clauses or in a case-by-case manner. Because heating rates were based originally on the prices of other fuels, commissions can argue that, as a matter of consistency, the rates ought to be increased as the prices of the alternatives increase. If, indeed, coal and oil prices had been higher in the thirties, then many of the gas transmission and distribution companies probably would have set their space-heating prices at higher levels.

Early buyers of gas heat are not disadvantaged by an adjustment of their rate schedules to other fuel prices. Their fuel bills are not relatively higher than in the beginning of gas heating. Experiencing belated rate increases now, they lose the windfalls, of course, that represent changing differentials between fuel prices. To defend their gains, these buyers may wish to argue an anticipation of the increasingly favorable price differential, though such an argument presupposes a good deal more foresight than consumers usually show. Later buyers, particularly the new heating customers of the forties, have a better case against proportionate price adjustments. In some measure they were influenced by the declining differential between gas and other fuel costs. If a consistent price relation between alternative fuels is the regulatory rule, it should be adopted before a lagging regulation misleads consumers, manufacturers and distributors of appliances, even architects.

Such a pricing policy admittedly restricts sales that are associated with coal and oil prices. But it does not provide means of price revision as a demand response (illustrated in Figure 1) evolves, or as errors in estimated demand schedules are discovered. And it gives no control of sales that are connected with increases in demand—with higher family incomes, changes in home designing, and so on. Most of all it gives no attention to any costs as means of price control. Perhaps gas-price changes relative to alternative-fuel prices neglect opportunities for economical additions to sales with lesser price changes. Some sense of efficient output controls calls for consideration of cost-output relations, either the cost behavior within an existing plant or beyond it. At best this simple pricing policy, dealing exclusively with a part of the demand conditions, is suited to a situation in which available plant capacity is fully used. It stops some of the clamoring for more gas furnaces. It moderates the gas shortage condition that is a matter of comparative prices of substitutes.

A second possible policy turns marginal-cost changes into price changes within the limits of an established plant. That is, if the demand changes, an increase in marginal cost (incurred to serve additional buyers) is translated into a higher discriminatory price for space heating. But the marginal costs may be low and approximately constant over most of the plant-output range. Starting with a high-pressure line and its complements of compressor stations, a transmission sys-

[7] A question arises, of course, about the way in which coal and oil prices are combined to form an index for gas-price changes. Since the discussion concerns mainly a general rather than a precise relationship, I shall not pause to puzzle over this matter.

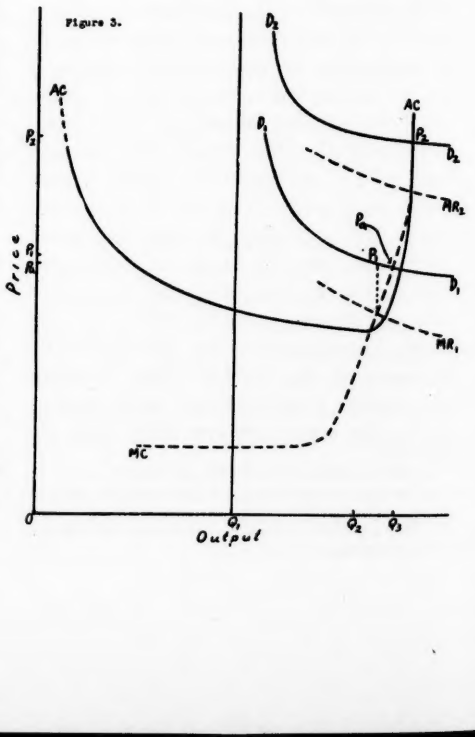
tem (treated as simply an operating part of a whole field-to-consumer system in the remainder of this section) incurs mainly the additional costs of gas purchases and variable compressor operations until output approaches the capacity limit of existing equipment.[8] Calculated for a single pipe line, the field prices of gas probably are uniform or nearly uniform regardless of the quantities purchased. And compressor operations are not likely to involve sharply increasing or decreasing costs within common capacity limits. Consequently, the marginal-cost control of pricing necessarily occurs beyond the output limits of these low and approximately constant marginal costs.

Increasing marginal costs are encountered primarily as attempts are made to adapt the existing plant to more output capacity. More compressor equipment and loop lines around large consumption points add to pipe-line capacity, and adaptions of distribution plant also increase output capacity. Such plant changes, translated mainly into additional capital and maintenance costs per manageable output unit, probably involve sharp and rapid increases in marginal costs. Marginal-cost control becomes effective near the limits of plant capacity. This fact is a result of the high plant adaptability relative to gas inputs and low adaptability relative to labor and capital variations that characterizes the natural gas industry.

In Figure 3, used to illustrate the second pricing policy, the sales other than those for space heating are assumed to be fixed at an OQ_1 quantity. Such an assumption allows costs and prices of heating service to be determined (illustrated) apart from other services, and avoids difficulties with joint costs. Space-heating demand (D_1D_1 or D_2D_2) is drawn as though the vertical line from Q_1 is the y axis. The marginal-cost curve, MC, is approximately constant until the limit of plant capacity its approached. And the sharp upturning of the AC and MC curves indicates the low adaptability of the plant.

Given the demand of D_1D_1, the company obviously does not have enough plant capacity to fix a price anywhere near the low, constant marginal costs in the middle capacity ranges. Seeking the most profitable (discriminatory) price, the firm chooses a price of P_1 that is determined by the equation of MR_1 and MC. An alternative and somewhat less profitable price is P_a that represents, as in recent suggestions of marginal-cost pricing, an equation of MC and D_1D_1. If, by chance, the demand is as high as D_2D_2, the price, P_2, is really an equation of demand to plant capacity; and mar-

Figure 3.



[8] While transmission facilities, the commonest point of strain in the present "shortage" situations, are used to illustrate constancy of marginal costs, the distribution systems can be used in somewhat the same way. Customer costs, which may represent all or nearly all the "necessary" additional costs of space-heating service with unused distribution capacity, are a case of approximately constant marginal costs per additional buyer.

ginal cost ceases to be directly significant in price control.[9]

This pricing policy introduces a cost control that is lacking in the relative-price policy, but it still has evident deficiencies. Marginal costs of space-heating service are determined by a sort of arbitrary segregation between services, and vary according to the amount of unused capacity. As a further fact, the low adaptability of the plant limits the range of cost control. In Figure 3 this range for effective marginal-cost control is between approximately OQ_2 and OQ_3. A company may well choose the price at which available output can be sold, and make as much or nearly as much money as if troublesome calculations of marginal cost are undertaken.

A third and more sensible means of price determination is associated with long-run costs of natural gas service—with the average or marginal costs that are incurred in extending transmission or distribution facilities. This sort of cost control clearly is at odds with the cost views that were commonly held as the heating market began to develop in the thirties. The conditions of unused plant capacity and low "additional" costs are not relevant to the present pricing case, and company managers as well as commissioners can well forget them. As a further relevant fact, current plans for pipe-line expansion (and some expansion of distribution systems) are associated with changes in heating demands, and can be imputed in some large measure to this class of service. In fact, an assumption, used here to simplify pricing analysis, of plant expansion for space-heating service alone is not altogether apart from reality, though new pipe lines are being planned or built for both heating and industrial service.

To compute the long-run costs beyond present plant limits, each workable change in basic plant capacity (e.g., another pipe line and its related equipment, or a sizable supplement to distribution capacity) is represented as an average cost. Each such aggregate of investment cost is translated into average depreciation, interest, tax, and maintenance costs that are added to average variable costs (e.g., gas purchases) to determine the average cost of the particular extension. A discontinuous series of these average costs provides the basis for a cost curve, and is a working means to price determination. These average costs represent various "planning" possibilities for a system and are not necessarily the explicit experiences of the system or industry. Indeed, price determination according to cost anticipations avoids the possible difficulties that follow, as in the current case, from consumer adjustments to low cost-price relationships. After actual costs are incurred the commissions can make the corrections for limits of resource use and reasonable earnings.

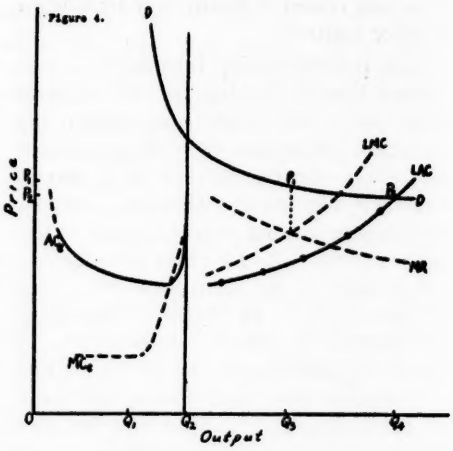
In Figure 4 the AC and MC curves, which are applicable to the existing facilities, are cost curves such as those of Figure 3. The vertical line at Q_2 represents the limit of existing plant capacity; and costs and prices are figured beyond this limit. The demand curve, DD, is based on anticipations of coal and oil prices, buyer incomes, and home-construction trends. Calculated originally with the Q_2 line as the y axis, the DD curve is moved to the left by the quantity that can be served with established plant —by the amount between, say, OQ_1 and OQ_2. (Again, as this arrangement of the DD curve suggests, the sales for other

[9] With P_1, P_2, or P_3 in Figure 3 the gas system clearly obtains additions to its net earnings, and the regulatory commission may wish to eliminate the excess. The heating price must not be changed, of course, unless there is no point in the demand-cost relation in the first place. These additions to net earnings can be used to reduce prices to the buyers who have price inelasticities of demand and probably do not yet enjoy much pricing effect from natural gas economies.

services are assumed to be fixed. (The long-run curve of average costs, LAC, is drawn through the several points of average-cost measurement, and the long-run curve of marginal costs, LMC, is derived from LAC.

The LAC curve may be shown with different and more complicated forms than what is given in Figure 4. For one thing a series short-run cost and U-shaped curves can be shown in place of the present discontinuous calculations of average costs; then the present LAC curve is tangential to the several short curves. Allowance may be made for understandable irregularities of cost behavior and calculation so that LAC cannot be fitted in an easy, freehanding fashion to a series of cost points. In the beginning, too, the average costs may decrease as some economies of scale are realized.[10] Emphasis is placed here on the increasing nature of long-run costs. Sales diversification between consumers probably decreases, field costs of gas are likely to increase, a higher obsolescence risk may be anticipated as more lines are built from even a large gas pool such as the Panhandle or Hugoton, costs of right-of-way leases can increase, and naturally the usual managerial diseconomies may be experienced as the system grows. In any case the LAC curve serves to illustrate the idea of price determination.

As indicated in Figure 4, the company and commission have a range of intelligible pricing choices. The range is between P_1 and P_2. Seeking the maximum addition to profits, the company chooses P_1 that is determined by the equation of LMC and MR. This is the new discriminatory price for space heating. To hold the company to a reasonable return,



a commission seeks an equation of DD and LAC at P_2.[11] Selling Q_2Q_4 at P_2, the company obtains an addition to total revenue that equals the aggregate addition to total cost. Yet the profits of a considerably curtailed output and a somewhat higher price are likely to be attractive to the private firm and, unless the commission does something to push plant expansion toward an equation of DD and LAC, this maximum economic limit of service is not realized.

Choosing a price according to long-run costs, the company and commission forget about costs under prior conditions. They forget about costs in the OQ_2 area of Figure 4. A price such as P_2 of Figure 4 is computed relative to plant extensions, but it is charged for the whole output of space-heating service. A commission may want to compute some costs under AC_e conditions, add costs incurred beyond the Q_2 line, and have a total cost that is turned into an average price.

[10] For example, the average costs (long-run) decrease as the size of the additional transmission line increases until, as a matter primarily of current technology of pipe manufacture, the line has a diameter of 20 or possibly as much as 26 inches.

[11] I am aware that some persons, attracted to reasoning on marginal-cost pricing, may prefer an equation of LMC and DD. Such a price determination, well beyond careful examination here, raises a question about what disposition is to be made of the excess return. If the excess is used to reduce the rates of other buyers, the possibility of a larger social benefit from more heating service (e.g., extension to OQ_4 where DD=LAC) is left out of account.

Such a price, taking account of low costs in the OQ_2 area and being below P_2, would leave some unserved buyers at the price and the shortage would persist.

These three suggestions on gas-pricing policy have a common characteristic: higher rates to control the limits of space heating. In the first one the gas prices vary proportionately with coal and oil prices. Reckoning with the substitutability between coal, oil and gas, a regulator is cognizant of a demand factor of the problem but lacks attention to cost conditions. In the second suggestion, which is confined to short-run operations and an existing plant, cost control is provided but it is effective only near the limits of plant capacity. Finally, if long-run costs are used, the range of output control is broadened and made more directly relevant to production plans in the natural gas industry. Construction of additional pipe lines is a fact or is planned; the unsettled matters are the amount of plant expansion and the prices of space-heating or other gas service.

IV

Lacking knowledge of discriminatory pricing and working with notably simplified versions of cost and demand concepts, commissions are poorly equipped to deal with pricing and production problems in the space-heating market. Price increases are not commonly considered in cases involving shortages of natural gas. Commissions approve temporary restrictions on gas service,[12] but they do not examine closely the demand changes and cost behavior that are important facts in the situation. Even when an Illinois company, losing its source of natural gas, built a gas-manufacturing plant and thereby incurred higher costs of heating service, the commission did not approve higher rates; it wanted to "avoid . . . hardship to a group of customers."[13] On the other hand, in two cases, both decided by the New Jersey commission, higher gas rates were granted in part because fuel oil prices were much higher.[14] The commission approved all of one proposed price increase and part of another. And a Massachusetts company was allowed to turn cost increases for the system as a whole into higher heating rates.[15]

As the construction of transmission lines and expansion of distribution systems provide more capacity for space heating, the commissions usually do not give close attention to the increasing costs of the service.[16] Although commissioners commonly knew about the low incremental costs of space heating service in the thirties, they apparently are not disturbed by the large current increment in plant investments. They do not mention the need for higher prices. Most of the available extension cases are decided, to be sure, by the Federal Power Commission that does not control space heating rates. In one case this commission observed that the Chicago retail rate for home heating had not changed since 1933 and that gas heating was planned for about 50 per cent of Chicago homes; but it said nothing about the increasing costs of the service, about the possible basis for

[12] *Re Long Island L. Co.* (N. Y.), 45 P.U.R. (N.S.) 133 (1942); *Re Milwaukee G. L. Co.* (Wis.), 65 P.U.R. (N. S.) 193 (1946); *Re Milwaukee G. L. Co.* (Wis.), 66 P.U.R. (N. S.) 117 (1946); *Re Gas S. Co.* (Mo.), 68 P.U.R. (N. S.) 155 (1947).

[13] *Re Illinois Iowa P. Co.* (Ill.), 54 P.U.R. (N.S.) 154, 158 (1944).

[14] *Re Public Service E. & G. Co.* (N. J.), 66 P.U.R. (N.S.) 28, 31 (1946); *Re Jersey Central P & L. Co.* (N. J.), 66 P.U.R. (N.S.) 129, 138 (1946).

[15] *Re Boston Consol. G. Co.* (Mass.), 70 P.U.R. (N.S.) 1 (1947).

[16] *Re Wisconsin Southern G. Co.* (Wis.), 45 P.U.R. (N.S.) 8 (1942); *Re East Ohio G. Co.* (F.P.C.), 52 P.U.R. (N.S.) 91 (1943); *Re Wisconsin Southern G. Co.* (P.F.C.), 56 P.U.R. (N.S.) 65 (1944); *Re Memphis Nat. G. Co.* (P.F.C.), 56 P.U.R. (N.S.) 271 (1944); *Re Panhandle Eastern P. L. Co.* (F.P.C.) 59 P.U.R. (N.S.) 38 (1945); *Re El Paso Nat. G. Co.* (F.P.C.), 64 P.U.R. (N.S.) 152 (1946); *Re Mississippi River F. Co.* (F.P.C.), 65 P.U.R. (N.S.) 184 (1946).

higher prices.[17] And the Wisconsin Commission encountered what seemed to be a condition of increasing cost, and still gave no apparent attention to new cost-price relations.[18] The regulatory interest centers on more gas service rather than price revisions that control the economical limits of operation.

Operating in their current manner, commissions may shift costs of service to other buyers. Additional pipe lines and possibly more distribution facilities are built, let us suppose, so that the current bans on gas-burner installations can be lifted. If so, the additional plant is installed to serve primarily space-heating and industrial buyers instead of buyers in general. Yet, by the time a case comes to the commission, the reason for additional investments and higher prices can be somewhat forgotten. And other cost changes such as higher wages, which are associated with all classes of service and are further facts of the case, may encourage the regulators to order general or even proportionate rate increases. At any rate the commission, fearing charges of discriminatory regulation, is not anxious to single out the heating buyers for price increases.

Separation of transmission and distribution operations seems to increase the chance that costs can be shifted away from the space-heating class. Gas transmission is handled commonly by companies and frequently by corporate interests that are not engaged in gas distribution. This means separate cases about wholesale and retail prices. Furthermore, the regulatory work is likely to be divided—transmission cases by the Federal Power Commission and distribution cases by state commissions. Thus, when the Power Commission grants higher wholesale rates, the distribution company and state commission may not direct all or a large part of the increase toward heating service. They may not inquire into the reasons for additional transmission costs before they change rates to final consumers. General rate changes are easier to figure anyway.

V

The case of space-heating prices shows how commissions can use knowledge of such concepts as discriminatory pricing, price elasticity of demand, cross elasticity of demand (or simply substitutability between commodities), marginal costs, and optimum operations. And it shows, too, the need for factual studies of demand and cost behavior. Guided by this knowledge, heating prices relate demand and cost conditions to each other, and serve to economize the limits of operations. They are means to efficient production and regulation. Yet the commissions scarcely show an awareness of a pricing problem in the heating market, and are much inclined to urge simply the construction of more plant. And if the pricing problem is identified, the familiar accounting procedure for reasonable earnings control is likely to be adapted to a solution. In this regulatory environment the shortage of natural gas can last indefinitely—or as long as gas fields are available to serve the lucky ones.

[17] *Re Natural G. P. L. Co. of Amer.* (F.P.C.), 64 P.U.R. (N.S.) 129, 151 (1946).

[18] *Re Milwaukee G. L. Co.* (Wis.), 66 P.U.R. (N.S.) 19 (1946).

Research in the Succession of Farms: A Comment on Methodology†

By KENNETH H. PARSONS*

THE succession of farms has recently come to be considered as an important problem in land tenure,[1] but as yet relatively little progress has been made in this field of investigation. The present statement attempts to outline the issues that are involved in a research program in the analysis of succession. Obviously, the statement must be tentative at this time; it can do no more than explore the issues and suggest ways of dealing with them.

The succession of farms may be viewed as a broad and inclusive category—with "farms" including both real property and the operating unit as a going concern and with "succession" including all transfers of occupancy, use, or title to a successor. In each instance the successor takes the place of the predecessor in the assumption of responsibilities, rights, or duties. In the usual practice, the basic vehicle of succession is the title to the real property; title always passes to someone whenever the rights of the current holder are relinquished, either voluntarily or by death. Whether or not the operating unit is held intact and passed on to successive occupants of the farm is an independent question, but the independence is a matter of degree according to the tenure status of the occupants. In its broadest connotations therefore succession may include a wide array of transfers—the scale in real property running from a willing sale between two parties to the operation of the laws of descent.

The problem of succession in current discussions is conceived of primarily as a part of the sequence of family transactions. Stated differently, within the broad field of activity which may properly be designated as succession, attention is being directed to family arrangements in succession. The central question is whether and to what extent family arrangements are limiting factors in succession processes.

Attention has been directed in recent years toward succession as a problem, in this family sense, from a number of different sources; an attempt is being made to coordinate these several more or less independent lines of investigation through the research planning program of the North Central Land Tenure Committee.[2] An extensive review of these different lines of investigation is beyond the scope of this paper, but note may be taken of representative inquiries which have contributed to the formulation of the problem—studies of father-son agreements, inheritance, capital requirements, and tenure arrangements.

For many years agricultural economists have been interested in father-son operating agreements on farms. The typical problem in these agreements involved business arrangements between

* University of Wisconsin.

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[1] For the most recent comprehensive article, see: W. L. Gibson, Jr. *and* Arthur J. Walrath, "Inheritance of Farm Property," *Journal of Farm Economics*, November 1947, pt. 1, p. 938. The footnotes provide a good bibliography to the literature.

[2] Sponsored by the Agricultural Experiment Stations of this region and the Bureau of Agricultural Economics, U.S.D.A., aided by the resources and facilities of the Farm Foundation.

parents and son for participating in the operation, expenses, and income of the farms.[3] It has been a common experience of persons counselling farm families on these matters either to have the uncertainty of the future ownership of the farm undermine the security of expectations of the son (usually a tenant) or to have a thoroughly satisfactory operating agreement abruptly terminated by the death of the parents. One tentative conclusion is that enduring and satisfactory father-son operating agreements cannot be worked out unless coordinated with some plan for the eventual transfer of the title to the farm.

In somewhat parallel fashion several independent studies of inheritance, capital accumulation and land tenure have pointed to the conclusion that the family management of capital, including planning for the assistance to children in meeting the minimum needs for risk capital, might be strategic in the ownership of farms by operators.[4]

These several lines of interest converge to raise the question as to whether improvements in succession arrangements may not introduce more security of expectations into the operations of farms and facilitate more satisfactory transfer of title from one generation to another. There are good grounds for the supposition that we may be able to improve the prospects both for owner-operatorship and genuine family farms by attention to the problem of succession.

One may suppose that concern about succession has a peculiarly American slant. In one aspect the central query is, how can American farm families learn to work together better in this area of experience? In many countries the matter of passing the farm to the next in line is simply a settled affair. Custom and family procedure are one. But in this country we seem to have experienced a sea change, to borrow an idea from Professor Toynbee,[5] so that the ties of kinship are not as strong as in the older countries from which we and our institutions derive. Whereas students of social affairs in the Orient, for example, are concerned about ways to break the grip of "family" on economic life, we are struggling to figure out ways of avoiding some of the penalties in American agriculture of an atomic individualism in a market economy. In America the law gives children no equity in the estate of living parents; the term "minor" refers to the fact that a child has no legally recognized will of his own. This vesting of property and legal authority in the head of the family is a part of our "individualism." But it means, also, that genuinely democratic family life, including democratic family planning on matters of farm succession, becomes a challenge for achievement. I remember quite well the amazement of one of our Chinese students when he saw the terms of a contract under which parents had sold the home farm to a son. "In China this could not happen," he said. Then he added, "In China we are trying to break the family down; in America you are trying to get people to work together."

The effect of all this is that family cooperation in America falls within the domain of voluntary group association. The leading principle is that a citizen shall have some choice about what groups he joins—and to a decreasing degree in recent years about whether or not he will enter into some form of collective action.

[3] See for example E. B. Hill, "Father and Son Farm Partnerships," Spec. Bul. 330, April 1944, Michigan State College, A.E.S., East Lansing, Michigan.

[4] For references, see footnotes to Gibson and Walrath, "Inheritance of Farm Property," or L. A. Salter, Jr., "Research in Landed Property," *Critical Review of Research in Land Economics*, University of Minnesota Press, 1948, Chap. VII.

[5] Arnold J. Toynbee, *The History of Civilization* (abridged) (Oxford University Press, 1947), p. 105.

The evidence is pretty clear that a single individual starting out on his own with only his abilities as assets cannot reasonably expect to acquire ownership of a productive midwestern farm in a lifetime, at least under prevailing credit terms. Furthermore, the combination of the natural life processes of man, individualism in economic affairs, and a strict investment attitude toward land will almost inevitably lead to some sort of absentee ownership of farms. Essentially in America the choice in the private ownership of farm land is between the family and the corporation. A family investment program leads naturally to absentee ownership when some members of the family move to the city. But family planning may also be directed toward facilitating the ownership of the farm by the member (if any) who becomes the occupant and operator of the family farm. The corporation ownership is not a hopeless alternative by any means, but a vast new effort to reduce rights in corporate-owned farms to a mere investment function would surely come as a consequence to corporate ownership in order to give farm families that degree of independence in action and the minimum security of expectations in the occupancy and use of farms which a vital rural civilization requires. But there is the traditional and time-tested principle of family ownership of farms which remains to be explored by genuine research.

When investigators turn their inquiries toward understanding the nature and foundations of family farms, as the term is used by farm people, they will find their researches coming to grips with a comprehensive complex of relations. Traditionally, agricultural economists in this country have defined the family farm in terms of labor required to operate the farm; a family farm is "one of such a size that the family does most of the farm work, with some hired help."[6] More recently definitions of the family farm have been proposed which add several characters to the definitions. These new definitions recognize that (a) some minimum size and income are necessary, and that (b) the conception must provide room for genuine management decisions and control.[7] When the "entrepreneurial functions," or "the technological management and business functions," are analyzed in actual situations, it will be found, one may predict, that this management discretion cannot be made secure without systematic attention to tenure status and expectations.

This is not the place to develop a truly comprehensive definition of a family farm.[8] But when such is done the general idea will also be at one with the general import of the family farm ideal held by farm people. It seems quite clear to me that the leading principle is simply this: a family farm is an organization which gives reasonable assurance that the collective will of the family shall not be defeated either by arbitrary acts of other parties or by the circumstances of small size or unstable income. Furthermore, family planning in this content should be viewed as including projections beyond the lifetime of the parent-operators. Even with these further qualifications all that is implied is that the farm should offer a reasonably sufficient vehicle or instrument for family security. It is the function of tenure arrangements to provide security of expectations in occupancy and use of the land (or, if you prefer,

[6] G. F. Warren, *Farm Management*, (Macmillan: 1913), p. 239.

[7] J. M. Brewster and H. L. Parsons, "Can Prices Allocate Resources in American Agriculture," *Journal of Farm Economics*, November 1946, and the *Report of Committee No. 1*, International Conference on Land Tenure, recently published as *Family Farm Policy*, edited by Ackerman and Harris, (University of Chicago Press: 1947).

[8] See also O. J. Scoville, "Measuring the Family Farm," *Journal of Farm Economics*, May 1947, pp. 506–19.

secure access to land resources.) A year-to-year lease gives security of expectations against molestation or disturbance during a crop season. It is conceivable that rental arrangements could provide long-time security of expectations, but in America this security has not been achieved. Practically, and by and large, in this country only ownership with limited indebtedness has yet given farm operators adequate security of expectations so that they can plan a long-time production program. To an even greater degree this is true in planning for their whole career, including old age security and helping the next generation get started on their own careers; the sons of owners have more secure occupational alternatives to choose among than do the sons of tenants.

It is in this context that improved judgments in the planning of succession programs hold the promise of contributing to the stability and welfare of farm people and rural civilization generally.

I

The practical problem of succession of farms is therefore a part of the larger matrix of day-to-day problems of achieving security of expectations in farm operations, accumulating equities in farms, and transferring certain benefits or interests to members of succeeding generations. In order to avoid excessive length in this paper we shall assume simply that some thinking about passing the farm to the next generation is a real problem for a considerable number of farmers. Many observers consider it one of the major practical problems of farm families; other persons rate it lower. But considerations of the proportions need not detain the argument; we simply grant that it is a practical problem and proceed to consider the investigational problem presented.

The investigational problem of succession is related to the practical problem in this way: any farmer (family) facing the alternative ways of relinquishing the responsibilities of operatorship and distributing his property among his children must make practical judgments on the matter. Judgment is involved in any case, whether he judges it better to do nothing and let the laws of descent operate or to act affirmatively. The point is that research comes to bear upon this problem through the possible improvements in these practical judgments of farm people. Essentially successful research on the problem of succession would so investigate the general problem that controlled or scientific judgment could be formulated which would test out the possibilities of improving succession practices in typical cases. The task of research is to provide accurate and dependable bases for judgments which will point the way to, or demonstrate how characteristics of successful succession practices are interrelated. The scientific resolution of a problem requires that research point the way to remedying the difficulty through suggested ways for reconstruction of the situation.

It is implicit in the viewpoint presented in this paper that the function of scientific analysis in this context is to provide the materials for the possible improvement in the practical judgments of farm people. We should strive to improve, not to replace, the common sense judgments of day-to-day acting of farmers. In effect this shifts the emphasis away from the distinction between pure and applied science and restates the issue as a distinction between scientific judgments which aim at establishing truth and practical judgments which are directed to the use and enjoyment of immediate resources. The tasks of research

therefore follow from the requirements of judgment in this kind of a problem.

Stated in simplest terms any judgment involves a welding of fact and idea.[9] The facts state the relevant potentialities; the ideas state the possible ways of acting with reference to those potentialities. Good judgment consists in the ability to select the possibilities which will actually broaden or make secure the potentialities in a situation. Stated differently, a judgment may be analyzed into a syllogism wherein the major premise is a theory, ideas; and the minor premise is a set of assertions of fact. Research comes to bear upon the improvement of practical judgments in three ways: (a) through clarifying the ideas used; (b) through providing relevant facts; and (c) through analyzing the actual experience in practical judgments to see what the consequences of similar judgments have been. It is through the latter type of investigation that the valuational aspects of the problem can be investigated. No one phase of the investigation can be carried very far without consideration to the other aspects, but in the exposition of the investigational procedure it is necessary to deal first with the different phases one at a time.

II

We begin by considering the theoretical problem. No field of inquiry is worthy of the name unless and until a relevant explanatory theory is developed. In fact the succession of farms as a field of research really cannot be defined until a body of relevant succession theory is developed. As the field is explored the theory will be developed, if at all.

The theory, or ideas, to the judging farmer, will be the meaning to him of alternative succession practices. For him, the idea-meanings should help him select those practices which lead to the consequences which he judges to be desirable. This is his philosophy of life in this area of experience. Typically, he needs some set of idea-meanings which enable him to relate such considerations as the following: his own prospects for survival, the care for his wife until death, some regular income to meet the cost of living for himself and his wife, the possibilities of assisting his children, the desirability of keeping the farm in the family, the possibilities of continued operation of the farm as a going concern, and the effect of alternative ways of handling his property upon the physical condition of the farm. There is a real problem of research in clarifying this system of meanings and getting the issues in true perspective or relation to each other. This can be done, one may infer, only by actually finding and drawing out the implicit meanings or ideas from analysis of interviews and the experience of farmers.[10]

[9] This suggestion that we take judgment as an analytical reference point may require some further elaboration. For some months, or even years, my conviction has been deepening that explicit attention to the elements of judgment might be extremely fruitful in economic analysis. In one sense the suggestion is that we substitute judgment for the narrower concept of choice. Furthermore, a judgment has parts which can be analyzed separately and as they function together. More significantly, the concept of a judgment appears to offer a vehicle for straightening out the relationships between theory and fact generally, as well as between economic theory and statistics. If so, the way is opened for systematic coordinate use of the various social sciences as they come to bear upon a problem. In the nature of the case succession problems involve many different aspects of farm people's experience which are usually analyzed by separate studies of property, tenure, family life, farm management, etc. The intellectual grounding of this incorporation of judgment into social analysis in this instance is from Dewey's *Logic*. However, one finds the term judgment appearing frequently in economic writings—but so far as I am aware no one has ever tried to include judgment formation within the analytical framework of economic or social research. As a minimum, the explicit recognition of judgment requires that we formulate the relationship between propositions and judgments. See Dewey, *Logic*, (New York: Henry Holt & Co., 1938). Esp. Part II, "The Structure of Inquiry and the Construction of Judgments."

[10] For the results of such an effort see, "What the findings may mean," Part IV, p. 14 to 28, Parsons and Waples, *Keeping the Farm in the Family*, Wis. A.E.S. Res. Bul. 157, September 1945.

But there is a more general scientific problem of theory in the investigation. This theoretical interpretation must, presumably, be built up concept by concept. The general theory which embraces and incorporates the particular "philosophies" of the individuals (as possibilities) must be an integration of the relevant parts of many theoretical systems: of law, farm management, financial management, capital accumulation, family processes and relations—at least these. If farm succession is taken seriously as a field of research, we shall need many monographs even with main emphases upon the various aspects of the theory alone. Gradually there will emerge, if the research is prosecuted successfully, a body of interpretations which explains how the various aspects are related together in the explanation of succession. The explanations, of course, will be worked out as a part of investigations into facts; but here the purpose is to sketch out the task for theoretical formulation.

For example, we need to know whether and under what conditions farms operated by fathers and sons in cooperative arrangements actually are better- or worse- operated than those where father and son do not work together. Is the farm better conserved; is the livestock better cared for if the farm is owned by a family which has some prospective continuity for more than one generation? We need to know more about whether and under what conditions farms do run down with the aging and declining strength of operators working alone. We need to know the differential conditions of beginning farmers, and their relative rates of financial success as related to the assistance which parents have given them. We need to have many investigations of the way the "living law" actually operates in management of family finances, inheritances and settlement of estate interests.

In all these the theoretical interpretation is but a part of given investigations but the point here is that this theoretical task and function needs to be recognized for what it is. Unquestionably a good deal of constructive work can be done through interpreting what we already know in different contexts, but at best these interpretations will be suggestive concepts, mere fragments of theory.

This task of building an integrated theoretical interpretation appears to me to be quite formidable. The fields of knowledge which surround the succession problem have their own central problems and focuses. The laws of inheritance and estate settlement do provide for some minimum security for widows especially and for equality of treatment of heirs in the absence of testamentary dispositions. But the main task of the law is to settle disputes between heirs so that the title to the property will be clear. Formal economic analysis of the firm, at the core of the theory of farm management, really takes all the personal and property relations as given and has no concern with the social matrix even though the latter is really more fundamental than the firm organization itself.

In general it is clear that the core of the succession theory must be on the issues of choice, valuation or judgment. The law, as fact, is related to choices by defining the limits within which discretionary action must be channeled. Presumably, the conceptual core of the theory must somehow be a formulation of relationships discerned as a pattern within activity which coordinates the life cycle of a family, the processes of farm operations seen as a plan projected over a span of years, the real investment and real dis-investment processes of appreciation and depreciation of land, and the financial capitalization which meets the risks inherent in such a business enter-

prise. These appear to be in the nature of over-all dimensions of activity which is at the core of a family farm viewed as a coordinated process over a time span of one lifetime or more. In principle the theory should explain how these coordinations are achieved, how the potential performance is a permissible possibility within the working rules of the law and finally, it should explain how the idea-meanings, "the philosophies," of individual farm families are a realizable possibility within this general system of social relations.

Such a comprehensive theory of succession, as suggested, can be worked out only by investigation. Its function would be twofold: It should embrace the systems of meanings of farm people as possibilities. That is, the general ideas should be so clearly worked out that there are no real contradictions in the theory; this in turn can be used to help iron out conflicting ideas, eliminate discrepancies and fill in the gaps in the "philosophies" of farm people in their thinking about succession. This will make for more effective practical judgments by farm people.

But such a comprehensive theory of succession has a crucial task to perform in research into succession problems. Such a theory is required as the matrices of hypotheses. The hypotheses which actually guide effective research are not just *ad hoc* suggestions shaped up in a way that permits testing. These hypotheses are actually, as one careful student has recently phrased it, terminal hypotheses. They are conceptions elaborated from and anchored in basic systems of theory. Here as elsewhere, inquiry is a continuous and cumulative process; hypotheses gain more power as they are developed with reference to more and more inclusive ideas; but this more inclusive theoretical system can be developed in a tested fashion only by formulating a family of hypotheses as alternative explanations and then eliminating those which are less effective as explanations.

III

We now turn to a consideration of the generalization of fact through research. Facts are derived, of course, through the same operations as are the explanatory theories. The generalization of facts represents essentially the inductive phase of inquiry: the generalizations of theory, the deductive phase.

Research can contribute greatly to the improvement of practical judgments on succession problems by finding out the relevant facts, the general factual relationships that can be used by farm people in their different judgment contexts. Such factual assertions are essentially statements of the way things (including activity) are mutually and reciprocally involved one with the other in the succession processes. . Suggestions were made above as to the kind of information which is needed.

Here I add two qualifications which seem to present fundamental research problems: (1) Since the succession process operates through a series of judgments, the whole process needs to be visualized as a means-consequence relation. What was tried, by what means, under what circumstances, with what consequences? In principle, this amounts to saying that the consequences of past evaluations can and should be analyzed as facts. It is also intended that valuation as fact is always involved in practical judgments. It is for this reason that study of tenure practices or farm management practices always requires that we go out and interview and actually study the experience of farm people. And (2), since succession activities are in the nature of a temporal

sequence, the particular problem of analysis involved in the formation of narrative propositions needs to be faced and surmounted.

We may well consider the latter point first. It is becoming clearer to me that the temporal sequence in social affairs must be analyzed into some sort of complete units. That is, we do not, and cannot really analyze an endless process just as mere movement. Analysis implies some sense of direction in the movement. This issue is particularly relevant in succession research. It appears quite clear, for reasons which I shall develop shortly, that we must view the succession process in terms of such units as the life cycle of a farmer, or a family.

There are quite technical reasons back of this suggestion. In the first place,[11] analysis discriminates happenings into some units which we judge to be events. Thus events are a function within judgment, not within time itself. If this fact is overlooked we may find ourselves analyzing the life span of a farmer, for example, as a "succession of events" in which each seems to be "caused" by the preceding ones. While there are certain elements of continuity in a life history that can be related to what came before and what follows in ways that have elements of necessity in them, on the whole this procedure is suspect in the analysis of problems such as those of succession. The more appropriate mode of analysis is to construe a whole lifetime or a career as one event, and to consider the succeeding years as stages within this career.

The conditions under which a young farm couple embark upon a farming career can then be viewed and appraised in relation to the probable outcome of completed careers. Once a farming career is reduced, in analysis, to an event with analyzable parts, or sub-events, then the way is open for the genuine comparison of many careers at different positions in space and time, provided we allow for the peculiar and differential degrees of resistance which are the functions of particular space-time conditions.

The research advantages of somehow reducing many different careers to comparable events will be obvious to anyone who has attempted to understand and explain particular tenure histories of farm families. Methodologically, this formulation also avoids the conception of "cause" as force running through the life of a farmer, by which the initial financial push given by his parents is somehow conceived of as a power running through every stage of his farming career, and eventually pushing him up into a higher stage of wealth accumulation. I can only conclude that cause-as-a-force, running through a life viewed as a sequence of events, is simply confused analysis. A substantial gift from parents used as a down payment on a farm may make all the difference in the world in the way a couple starts farming; with life as it is there is no unavoidable and necessary connection between this "start" and the outcome of the career. Such a grant reduces initial obstacles and should be analyzed in these terms.

This view may seem paradoxial, in the face of the obvious fact that life is after all a kind of a history. Furthermore, any attempt to analyze a life history, as in succession studies, will resort to the formation of narrative propositions. The statements about a life history are made initially in narrative form; as these statements are reduced to systematic form they may take on the general form of "the parents made such and such tenure progress during some specified period of time and under certain specifiable conditions." If we follow out this analysis

[11] See Dewey's *Logic*, chap. XII, "Judgment as Spatial-Temporal Determination; Naration-Description," pp. 220-244.

carefully do we not eventually come out with the life resolved into a single event, with the "progress" marked off according to certain specifiable traits in the situation, and the pattern of the career itself reduced to a series of means-consequence relations? Through analysis we move from a temporal-sequence observation to a means-consequence explanation. When this is accomplished we can then relate the achievements in a career to the circumstances of the situation, what was attempted and what achieved.

It seems therefore that there are really different kinds of relevant facts needed for an understanding of a succession experience. Or, stated differently, any farmer interested in improving his judgments of what to do in regard to the passing of the farm down to the next generation needs different kinds of facts.

There are the general facts of the situation in which a career has its locus. These facts formulate the general conditions in comprehendable ways. Typically the questions are: what about the level and direction of prices, the amount of equity involved, the value and productivity of the farm, the number of prospective heirs, even the stability of the climate? Such items as these constitute the general facts of the case, revealing the dimensions of the potential resources and obstacles. If particular succession practices are to be evaluated, it is the practices that must be compared. This cannot be done unless ways are figured out to make allowance for such things as: "being born at the right time"; or the windfall of unusually high prices; or the number of children in the family.

Then there are possibly relevant facts about what we might call the mechanics of the succession process itself. The farmer should know what special legal or business devices have been worked out and are available for the mere taking—possibly at a fee: special contracts, provisions for life estates and remainder interests; amortization tables, life expectancy and annuity computations, and the making of wills. Knowledge of the availability of these various devices and the way they have worked out in other people's lives are also relevant facts. There is a great deal of work that needs to be done, merely identifying and evaluating these devices in general terms.

When the more external and mechanical elements of the situation are understood as facts, the way is then open to understand the actual workings of the succession process itself. The means-consequence relation—what was attempted, under what conditions, with what resources, and with what consequences—can then be investigated and understood. The means and the consequences are a part of the whole situation, in any case. But the bearing of both the general facts of the situation and the particular devices used needs to be estimated separately, before the final judgments of generalization regarding the means-consequence relationships are attempted.

The crucial and most difficult generalizations of fact needed to improve the judgments of farm people regarding succession activities and practices would seem to be the ones which formulate the means-consequence relation, showing the connections of purpose, activity, and consequences, with reference to specifiable conditions under which action occurred.

If we can actually make such scientific analyses of the operation of practical judgments on succession problems we shall at the same time deal with the valuational problem. The value of the means is to be found by analyzing the consequences in relation to purpose or intent. The particular consequences of a

specifiable act are to be rated by what was attempted. But what was attempted in any particular case should be viewed by the investigator against possible systems of meanings for individual farmers, which in turn are rated for general validity and effectiveness against the general theory of succession, which formulates the best explanation of succession conceivable without contradiction.

IV

In conclusion, and by way of summary, the suggestion has been made that research in farm succession should produce two different kinds of generalizations—of theory and of fact. To the investigator the theory will be the explanation of succession—*meaning* in a technical sense. To the farm people who formulate and act upon the practical judgments by which farms are passed from one generation to the next, this theory will be relevant only to the extent that it helps them clarify their own "philosophies" about keeping the farm in the family. On the factual side, the investigator will develop general facts both about obstacles to action and about the consequences of different courses of action with due regard to the extenuating circumstances of time and place. The farm people in their own way should be able to use these general facts to help them understand their own problems. Any person, or family, making a decision about leasing or selling a farm to a son will have many facts to consider which are unique to the particular situation. Research should illuminate the problem for them, provide guides and suggestions which will enable the practical judgments to be made more intelligently and with more security of prospect for a favorable outcome to the act.

Finally, we may view these possible findings all together from the perspective of a farm family trying to make a decision on a difficult and delicate matter. Viewed ideally the farmer would have a well thought-out idea of the whole thing—a plan of action. Also he would have a different set of propositions of fact for each of the major aspects of the problem. In each set would be some securely established general statement of fact—as well as the particular facts of his own case. One set of factual propositions would deal with cost and returns formulating alternative ways of operating the farm—by himself with his son as a hired worker; by his son as tenant; by his son as owner and the father as holder of a mortgage, etc. There would be facts about investment: about the various alternatives of retriement, retirement income, etc.; about different kinds of property arrangements; about how alternative ways of passing the farm along would influence the careers of the other children, and so on. In principle, each aspect of the situation which holds some reasonable probability of being a limiting factor in the total act of transferring the operation and /or ownership to the next generation would need to be analyzed. The farm family making such a decision does not need all the facts; they need only the most relevant facts. More precisely, before final judgment is attempted there should be a whole series of subjudgments which have the purpose of deciding which facts report strategic factors. In any situation two or three aspects are likely to outweigh all other considerations. Such is the economy of sound judgment.

Reports and Comments

Conservation Aspects of Land Programs*

THE underlying purposes of the land programs of the Department of Agriculture are: (1) The conservation and development of land resources—soil, water, forests, and range, and (2) the maintenance and stability of farm income through protection of the land-resource base. The accomplishment of these purposes requires an analysis of data regarding conditions, needs, and the wise management of our land resources. Obviously, these aims are closely related and overlapping. Basic to society's interest in conservation are our present and future food and fiber needs, including an adequate reserve for any contingency that may arise. Moreover, a better knowledge of our land-resource problems will enable society to improve the effectiveness of different programs that are designed to better the lot of the American people and that are set up to safeguard the Nation's capacity to produce food and fiber.

There is an arising revitalized interest in our needs regarding land resources and in land problems in the United States. This paper briefly reviews as background information certain conservation features of the land programs of the Department of Agriculture, but deals essentially with some of the economic issues in land conservation. Questions are raised and problems of land resource use are presented as they relate to conservation in farming and range areas.

Resource Needs

Not many years ago the Nation was grappling with the problem of apparent surpluses in almost all lines of agricultural production. While World War II was in progress, the surpluses disappeared and something approaching an all-out effort was made to increase production. However, the fear of surpluses remains and is a major cause of or reason for farm price-support programs and the marketing research program through which it is hoped to enlarge the outlets for farm products.

Available land and fertilizer and our improved technology indicate that agricultural production can keep pace with our needs for food and fiber. But it is difficult to forecast needs because of uncertainties as to the level of our population and the nature of our foreign policy. Population estimates for 1975 range from 162 million to 185 million persons, depending upon the assumptions used in regard to birth and death rates. If potential new land resources are developed in the United States and if American farmers manage the land in such a way as to maintain land resources—which one must recognize is not now being done in many areas—the Nation can rest assured that food and fiber can be produced to maintain all of our people in relative abundance, and that they will be produced provided an adequate distribution system is maintained and sufficient purchasing power enables the people to buy what they need. If a high level of general employment is not maintained, the position of American farmers appears to be vulnerable notwithstanding increases in population. The need for food in itself does not assure satisfactory farm incomes. Obviously, it is demand backed up by purchasing power that is essential. The rate of expansion of the demand for farm products depends upon changes in population, upon income, and upon consumers' understanding of nutrition and tastes or preferences.

The world need for agricultural production will continue to be great regardless of the situation in individual countries. Population in most countries is continuing to increase, even though local food supplies are short. In the Asiatic countries where large segments of the population have always been on the verge of starvation, population numbers stagger the imagination. One need not be a Malthusian to be concerned about poverty, under-

* The views expressed are solely the author's and do not necessarily reflect the official views of any government agency. The author wishes to acknowledge the suggestions given by a number of his associates in the Department and especially the assistance of Mr. Alvin T. M. Lee.

nourishment and even famine in many parts of the world.

A social consciousness has arisen among the nations as to the importance of doing something about the food needs of the peoples of the world. Agriculturally rich and productive nations like the United States have a responsibility not only to their own people but to distant consumers who depend upon the contribution this country can make to their food requirements. This can be done through an expansion of trade, through direct assistance in periods of emergency, and through dissemination of the know-how for increasing food production.

Features of the Land Programs

The programs of the Department of Agriculture are varied and complex in both their objectives and their operation. The types of action that have been taken to meet land problem situations have arisen essentially from deterioration of our resources, maladjustments in land uses, difficulties in land management, and conflicts of interest in the use and control of land. Rural poverty, ruthless destruction of our forests, ill-adapted land uses, land reversion, and situations incident to government land disposal policies are well-known manifestations of the problems. Conflicts of interest have existed between groups and also, at times, an incompatibility of interests between individual operators and the public welfare. This should not be alarming. The satisfactory working out of the conflicts is part of the democratic process. The basis for concern is the possibility that one group may so dominate the scene as to impair the interests of others.

Agricultural Conservation Branch and Soil Conservation Service. The action programs dealing with land problems were brought into being largely by economic depression, drought, dust storms and widespread soil erosion. These programs were devised to help solve or ameliorate problems that individual farmers, acting on their own and individual initiative, could not meet. Experiences have demonstrated that voluntary action on large national problems resulted in little if any accomplishment because the actions of some were neutralized by the actions of others. The scope of such problems is beyond individual control. Concentrated efforts toward a common goal and group action were needed if results were to be achieved.

In this setting the Agricultural Adjustment Administration was born. This agency has passed through successive changes. Its offspring now are the several commodity branches and the Agricultural Conservation Programs Branch of the Production and Marketing Administration. The Agricultural Conservation Branch has the responsibility for making payments to farmers for carrying out approved soil and water conservation practices. Some 50 approved practices are eligible for payments, and each state, in turn, narrows this list down to those practices applicable to the state. The county committees of farmers, in turn, select the practices applicable in their own county. In regard to conservation, one specific result of this program has been considerable reduction in loss from soil erosion, brought about by shifting production onto the better soils more suitable for cropping.

The Soil Conservation Service program is another illustration of the adaptation of a national program to local conservation needs and situations. The Soil Conservation Service is the facilitating agency for technical assistance in preparing basic conservation plans for the use, treatment, and management of farm lands. In the main, this planning service is rendered by some 2,000 soil conservation districts, organized under state enabling legislation. Farm plans have been completed for about 600,000 farms comprising more than 167,500,000 acres. Between the Soil Conservation Districts and the farmers, agreements on land improvement plans are arrived at through mutual understanding of problems and the necessary action to be taken for solution. The soil conservation districts have already demonstrated their effectiveness for dealing with soil and water conservation and hold even greater promise as a device in finding answers to many difficult land problems. Through education and demonstration, great strides have been made in getting across to farm people and the public the value and necessity of conservation; and through concrete action much has been achieved.

As a part of the recent Congressional hearings on matters relating to conservation, interest has been expressed in placing more emphasis on grass seeding, developing stock-watering ponds, terracing and other long-range permanent practices, and in placing less emphasis on government spending for lime, fertilizer, and recurring production

practices. Related to, but independent of the rise of this proposal is the problem of tying farm income payments to production conservation practices.

As stated at various Congressional hearings, the Department of Agriculture recommends the consolidation of the Soil Conservation Service and the Agricultural Conservation Division of the Production and Marketing Administration into a new agency. This is thought necessary in order to achieve the required perspective and balance and scope of vision to carry out properly a unified soil conservation program. Inasmuch as the activities of these two agencies are directed to the same objective—conservation and proper use of our agricultural resources—it is felt by the Department that the integration of these agencies should result in a substantial speeding up of conservation plans, an increase in the rate of putting conservation plans for individual farms into effect, more efficient conservation practices, and more efficient administration.

Forest Service. The United States Forest Service is another large conservation agency in the Department. In the management of the National Forests, the Forest Service has two key principles. One of these is called "sustained yield," and its objective is simple —to keep forest land yielding maximum returns. The other principle is "multiple use." This means that the various uses and services of a given forest area are coordinated in one over-all management plan. The Forest Service is concerned not only with timber crops but with wildlife, range forage, recreational values, water supplies, and other products and services associated with forest lands.

Flood Control Program. Reference to the work of the Soil Conservation Service and the Forest Service should mention, in addition to the conservation activities indicated, the flood-control surveys and operations—one of the Department's significant land conservation and development programs. These two agencies are responsible for the flood-control work in the Department. Because flood-control work that is well done modifies land uses and affects the farm set-up, it is particularly important that a well-rounded program representing different interests be carried on.

Credit Agencies. The use of publicly sponsored credit is another means of promoting conservation, particularly soil conservation. Both the Farm Credit Administration and the Farmers' Home Administration are concerned with soil conservation and through their programs are working for improvements in conservation practices. The Farm Credit Administration, through its loan policy, the adjustments of farm debts during the 1930's and other similar actions, has contributed to the conservation of farm resources by doing things that discourage exploitation. All the Federal Land Banks make loans for soil-improvement and farm-improvement practices. One land bank has developed a special type of soil-improvement loan for which a complete farm plan is required as a condition to the granting of a loan. Production credit associations also provide credit for soil-improvement practices.

In the case of the credit extended by the Farmers' Home Administration, approval of credit is based in part on the soundness of the farm as an economic unit and in part on the ability of the borrower to carry out good conservation practices and sound farm management. In the farm-ownership program, the agency maintains some degree of supervision during the life of the loan, and the contract contains a clause that the borrower will maintain and improve the farm and prevent wastage of resources. Both in the older 100-percent-direct-loan program and in the recently inaugurated mortgage-insurance program, the land is appraised on the basis of its productivity, and the loan is serviced and supervised to see that good farming and land-use practices are followed and that the security for the loan remains good.

The insured-mortgage program of the Farmers' Home Administration adds to the scope of the program and can be expanded greatly, for under it any private loan may be insured up to 100 percent of the mortgage, which can be for as much as 90 percent of the appraised value of the farm.

The farm-development and farm-enlargement loan programs of both agencies provide a means whereby uneconomic units can be developed or enlarged into efficient family farms and thus provide an adequate income without misuse of the soil. Loan funds may be used to establish conservation measures such as erosion-prevention practices, development of permanent pasture, basic soil treatment, drainage, irrigation, land clearing and reforestation.

Research and Education Programs. The De-

partment of Agriculture, the State Experiment Stations jointly and separately, and the Cooperative Extension Service have long been engaged in research and education on all farm problems. Achievements in the field of plant research, developments of new varieties of grasses and physical devices for controlling erosion are but examples of the many results of research. The extent to which the results of research are adopted by farmers depends upon the effectiveness with which the findings are put across to them. Farmers must be convinced of the soundness and profitability of recommendations before they will adopt them. The Extension Service is the general educational agency for implementing agricultural programs of both federal and state agencies. It fits into the over-all conservation effort through its close association with farm people.

Some Conservation Issues

Land Use and Conservation. A major problem in obtaining conservation and good land use is the economic and social adjustment that must first be made. Present types and systems of farming have often been developed on the basis of feasible and intensive systems of land use. In the South, for example, the typical farmer grows too much cotton for good land use practices, but in many areas it is the most profitable cropping system, considering the acreage available in the average farm.

Similarly, corn is a relatively profitable crop in the Midwest. However, in many parts of the area now undergoing heavy tillage, beef-cattle production would be more conducive to good land use than is production of cash grain. Operators on small farms cannot specialize in beef-cattle raising because neither the number of beef cattle nor the corresponding acreage of pasture and hay crops associated wth a small farm makes for a profitable enterprise. In order for the family to be effectively employed on a beef-cattle farm, the herd must be large and the corresponding acreages of pasture and roughage must be adequate.

Certain types of price-support programs and benefit payments may lead to practices that discourage diversified and conservation farming, one effect being to impair land resources at a rate in excess of immediate benefits received. It is uneconomic to maintain or prolong an intensive system of farming when doing so is possible only because of subsidies coming from the outside.

Some may fear that a change to a more extensive system of farming would result in reduced production of the products we need. This would be true if the changes involved only a shift in major uses of land. In the past most of our major agricultural crops have often been surplus in volume in comparison with needs. The trend in the demand for farm products has gone up more slowly than the trend in supply because supply has been notably stimulated by improved technology, by an advance in labor efficiency, and by the development of new land.

A recent study in the Corn Belt and Lake States by the Bureau of Agricultural Economics and the Soil Conservation Service deals with the probable effects on land use in this area if good crop rotation and soil-conserving practices were carried out. For the eight states as a group, increased yields obtained from the use of proved fertility practices and proved corn varieties would result in about an 18-percent increase in production of corn, about 12-percent increase in the production of small grains, but more than double the amount of feed from permanent pasture, rotation pasture and hay. Of course, only a part of these increases can be credited to conservation. Increased production could take place for a time without regard to conservation farming but the level of production could not be maintained.

Adoption of recommended rotation and land use in the Corn Belt and Great Lakes States would double this area's capacity for livestock production. A sudden shift in this direction could bring serious repercussions in other parts of the Nation as well as a shift in the normal relationship between livestock numbers and grain supply. But, of course, a sudden shift is not possible. And the effects of a shift could be minimized by increasing beef cattle relative to hog numbers, thus converting more roughage to meat. A further adjustment could be made by increasing the forage in the livestock rations. With modern methods of making hay, it is possible to put up hay with less loss of nutrients than formerly. Also the use of alfalfa and other high-nutrient roughage reduces the need for grain in the livestock ration. It is recognized that large investments would be necessary to make such shifts in land use and production.

In some areas, farmers are improving the fertility of their suitable cropland and so are able to retire the steep and eroded hill land

from crops and to shift it to pasture. Thus, through pasture improvement as well, they are increasing the total volume of production on the farm and changing to a system of farming and land use that will insure soil conservation. Conservational land use may involve intensification on land suitable for continuous cropland use and extensification on land subject to erosion—both intensification and extensification on the same farm.

Increasing the size of farms does not insure a conservational system of farming, although it may often be a necessary conditioning or facilitating factor. It is recognized that exploitation of resources is most serious on many of the large farms, particularly where one-crop tillage farming predominates. However, adequate acreage in a farm increases immensely an operator's opportunities to adopt a system of farming that will conserve the soil and yet yield enough income to provide him and his family with an acceptable level of living. It also permits extension of mechanized methods of farming that in itself gives support to conservation farming. Small farms under certain conditions are not conducive to conservation farming.

As good conservation farming in many areas requires enlargement of operating units, the opportunities for buying or leasing additional land is an important consideration in attaining adequate conservation. Farm income in general during recent years has been high and the advantages of expanding operations have been very apparent. In expanding their acreage farmers should consider changing their type of farming rather than continuing to emphasize production of the exploitative types of intertilled crops which are likely to accelerate erosion. It is recognized that farm land prices have gone up sharply and in many areas are now higher than would seem warranted by expected future incomes. This is a serious handicap to the adoption of desirable conservation practices. Too large a part of farm income is capitalized into land value and thus needed conservation practices and good family living must be sacrificed.

Institutional Factors. Among some of the conservation issues, the most difficult to meet are those of an institutional character. Tenure situations on both public and private lands, credit arrangements, and types and forms of district or local organization that bear directly upon conservation are examples. The public has long recognized the need for public ownership and management of certain kinds of land. However, many tenure issues arise even in lands held in public land ownership. To change certain of the customs and legal ways of dealing with rights in land certainly gets into the realm of controversial issues.

Early transfer of the farm from father to son is advantageous in a conservation system of farming. Under the present system of inheritance and transfer, most of the farms of the Nation are expected to pay for themselves each generation, to maintain improvements and conserve the land, and to provide a reasonable standard of living, including the education of children who later may move to the cities. Few corporations in the United States could accomplish a similar feat. We recognize the problem but little has been done to understand or deal with it.

Credit arrangement might be used to a greater extent than at present to encourage conservation. As credit is flexible and extended on an individual basis, it should be possible at least to experiment with new credit policies. For instance, might not more attention be given to the extension of credit to capable promising young men to enter farming? To start from scratch at present or near present price level, under the existing institutional set-up, and look forward to accumulating the capital required for the attainment of ownership of an adequate and efficiently operated farm is disheartening. If individuals should be expected to acquire unencumbered ownership during a lifetime from their productive efforts, could this not be achieved more readily by beginning the ownership process by the aid of credit in their twenties rather than their forties? It is, of course, recognized that incurring heavy debts to acquire ownership should not be encouraged during periods of particularly high land values.

In regard to conservation district organizations, it is well known that conservation achievements were to be sought largely through voluntary action, but it was recognized that, in certain instances, police power regulations may be necessary as a last resort to prevent a small minority of land owners from inflicting serious damages on neighboring properties.

Many of the State Soil Conservation District Acts enable districts to pass land use

regulation. Except for one district in North Dakota, Colorado is the only state where land use regulations have been adopted. In this state seven districts set up land use ordinances, based on land use capability classifications, for the control of breaking sod; six districts established sod land regulations requiring that certain tilled lands be basin-listed; and three districts adopted grazing regulations. In 1945, the Colorado legislature, because of agitation against the regulations, amended its soil conservation district law. One provision of the amendment nullified all land use regulations previously adopted unless they were readopted within 45 days of the enactment of the amendment. Apparently steps were not taken to reenact these ordinances, and presumably no land use regulations now are effective in Colorado. In an area like the Great Plains, it is questionable whether agricultural and grazing lands can be conserved and improved without group controls. It is also significant, even though understandable, that since 1939 only two states have provided for land use regulations and three states have deleted such provisions. The trend has been definitely away from granting land use regulations for agricultural purposes to local units of government.

Federal-State Relations. It is obvious that the implementation of conservation policy is affected by the operating relationships between federal, state and local governments. Existing issues and conflicts need to be faced. In the administration of a conservation program, one basic consideration is that the degree of responsibility exercised by any unit of government should be compatible with its specific interests in conservation but limited by the power and ability of that unit of government to assume responsibility commensurate with necessary obligations. An interest in a conservation program and a desire to assume responsibility by a state or local unit of government does not constitute grounds for decentralization of responsibility unless this responsibility can be adequately protected and so entrusted that all levels of government cooperate toward accomplishing common objectives. Conversely, extreme centralization of administrative functions that could just as well be executed by state and local units of government can lead to some of the alleged evils of bureaucratic institutionalization. The administration of conservation policies among units of government should be governed by rules of reasonableness in view of the interest involved and contributions made, both immediate and future, and the ability to carry out the degree of responsibility required to insure a successful program. There are many practical problems in this field calling for consideration and understanding.

Needed Economic Research

The development of a permanent conservation program that is both acceptable and effective over a period of time requires research in the economics of conservation. Such research is needed on problems of an over-all character as well as at the level of the individual operating unit. Through a comprehensive research program, valuable information could be obtained on the integration of sound conservation as a phase of good farm management practices, and on such questions as: (1) What is the significance of the problem of soil depletion in terms of future land requirements? (2) What are the total benefits and costs to different beneficiaries from alternative expenditure opportunities for conservation and various types of conservation measures? (3) What types of arrangements and inducements—tenure arrangements, capital requirements, incentive payments, administrative devices—are appropriate and necessary to obtain farm participation in conservation programs?

Under our system of landed property, individual benefits arising from soil conservation are largely the basis of total social benefits, and consequently society is interested in all net beneficial results arising from conservation. As the public treasury is limited, consideration must be given to alternative ways of getting conservation in any given area, as well as alternative investment opportunities for different types of land conservation development, with the objective always in mind of obtaining substantial social returns per dollar of public expenditure. The issue is one of how to spend limited funds so as to get the greatest social benefit. Also it would appear to be just good sound public policy and good common sense for individuals to bear the cost of conservation to the extent of their ability. The nearer benefits from conservation can be charged to direct beneficiaries the more equitable is the allocation of costs. One of the big issues of land conservation on private land is the extent of public participation necessary in society's interest and the manner in which aids are extended.

In the end, much of the support for and appraisal of conservation is a matter of public policy. Economic studies are significant in the process of forming policies as analyses of private and public interests in conservation are essential in arriving at or modifying value judgments in regard to conservation policies. The techniques and institutional devices and plans that are a part of conservation programs should be considered in an economic analysis of conservation as they are factors that affect economic appraisals. Research that emphasizes practices and adjustments needed to develop further both stable and profitable land uses and farm systems has a definite place in the field of land conservation.

During the last 20 years outstanding progress has been made in land and water conservation in the United States. However, much remains to be done; and throughout the world the picture is less bright. But with widespread public support and if the forward advance is not upset by some disaster, we may well bring about achievements that will have significance for the peoples everywhere.

V. WEBSTER JOHNSON

Bureau of Agricultural Economics,
U. S. Department of Agriculture

Agricultural Profit-Sharing in Puerto Rico

THE pressing world wide food shortage since the end of World War II has focused the attention of statesmen, educators, and scholars on the need for land tenure reform in various parts of the world. The objectives of such a reform are twofold: (1) increased production, and (2) greater security to those who till the land. The techniques for accomplishing such a reform are varied and require the combined efforts of the legislature, the courts, and private citizens. It is the purpose of this article to discuss a novel technique used by the people of Puerto Rico to accomplish a land tenure reform in that territory.

The organic act[1] for Puerto Rico provides that corporations engaged in agriculture in that territory shall be limited to the ownership of 500 acres of land. This provision was flagrantly violated from the time of its enactment, mostly by corporations engaged in growing sugar. The Congressional mandate and its subsequent violations proved to be a convenient political wedge for the inauguration of a vastly different system of land tenure than had theretofore prevailed. Relying on it, the Legislature of Puerto Rico, in 1935, provided that the government might institute quo warranto proceedings for the violation of this 500-acre law and, in the same proceeding, provide for the confiscation of such property by eminent domain.[2] This legislation was upheld by the United States Supreme Court in a proceeding against one of the corporations violating the provision.[3]

The insular government was then faced with the problem of distributing the land so acquired. It was felt that the most desirable thing was to have the people who tilled the land own it;[4] however, this would entail breaking the land into small parcels whereas efficiency of production, in many instances, demanded that large parcels be tilled as a single unit. Accordingly, the Legislatiure of Puerto Rico in 1941, established the Land Authority,[5] which is a seven-man board in the nature of a governmental agency with juridical personality. The Authority is given power to purchase, lease, and hold title to lands deemed necessary for the purpose of the act. Primarily, however, the Authority is to acquire the lands held in violation of the 500-acre law and to distribute them in the manner prescribed by the legislature.

To accomplish the acquisition of lands the Authority can proceed in one of three ways. It is granted the power of expropriation by which the Authority in its own right, or the Attorney General in behalf of the Authority,

[1] 31 Stat. 716, 48 U.S.C. 752, May 1, 1900. The provision was continued in the existing organic act. 39 Stat. 751, 964, 48 U.S.C. 752, March 2, 1917.

[2] Act. No. 33, Laws of Puerto Rico. Special Session 1935; Act No. 44, Laws of Puerto Rico, Special Session 1935; Act No. 47, Laws of Puerto Rico, Special Session 1935; Act No. 183, Laws of Puerto Rico, Regular Session 1941. In the proceedings, the court has authority to appoint receivers to take charge of the liquidation of the property and in all cases the receivers are to give preference to the Land Authority, which has a legal preferential option for the purchase of said lands for the fair price fixed by final judgment.

[3] *People of Puerto Rico* v *Rubert Hermanos, Inc.* 309 U.S. 543, 1940.

[4] Statement of Motives, Act No. 26, Laws of Puerto Rico Regular Session, 1941.

[5] Act No. 26, Laws of Puerto Rico, Regular Session, 1941

can institute judicial proceedings against any artificial person holding land in violation of the 500-acre law. In this proceeding the Authority can file a declaration to the effect that the property is sought for the Authority. The declaration is to contain, among other things, an estimate by the Authority of the just compensation for the land. When the declaration is filed and the sum deposited, title to the land vests in the Authority and the right to just compensation, as fixed by the court in the proceedings, vests in the Corporation. A second method by which the Authority can acquire land is by purchase from the trustees of land acquired in quo warranto proceedings. The trustees are to begin the sale of such land six months after the date of the trusteeship. For a period of one year thereafter[6] the authority has a preferential right to purchase such property for a just compensation. The third means of acquiring such land is in effect a declaration that the Authority shall not be estopped, by its failure to exercise its preferential right, from bidding at a public auction held by the trustees after the elapse of this period. Rather than being estopped the Authority may, by meeting the highest bid offered, acquire the land.

The lands so acquired may be disposed of in three different ways by the Authority. One of these three[7] methods—the division of the land into proportional-profit farms—will be examined herein because of the unique aspects of the program.

A proportional profit farm is established by a contract between the Land Authority and an administrator. The contract provides for the administration of parcels of land varying in size from 100 to 500 or more acres. The administrator must qualify as a farmer, or as an agronomist, or have experience in the field of agricultural management. He owns no interest in the land, legal or equitable, nor can he acquire an interest in the land. His compensation is fixed by the contract at not less than five, nor more than fifteen percent of the net profits of the farm.

The laborers on the farm are paid wages according to the prevailing wage scale in the community. In addition to this regular wage, they are, at the end of a fiscal period, entitled to a proportion of the net profits of the farm. The proportion to which each is entitled is determined on the basis of the number of dollars he has earned in wages.

The farms have no fixed assets. All implements, equipment, and animals belong to the general fund of the Land Authority. The Authority keeps all properties in a service unit which hires them to the farms. The farms have no cash of their own. Cash disbursements are all made out of the general fund of the Land Authority. The Authority finances all crops, makes all purchases and issues orders for all materials used. In turn, all income liquidated from the farms is deposited in the general fund. The following information, taken from the statement of income and expense[8] for the Cambalache project[9] for the 1946 crop, shows how the income is distributed by the Authority.

The project had a gross income of $1,236,709.56. From this was deducted the direct agricultural costs of $724,711.34. These costs include preparing, planting, fertilizing, cultivating, and harvesting the crop. There remained an agricultural profit of $511,998.22. Overhead expenses consisting of repair and maintenance of equipment, care of cattle, interest on crop financing, rent,[10] auditing expenses, insurance and taxes amounted to $320,485.34 which, deducted from the agricultural profit, leaves a net income of $191,512.88. The shares of the administrators amounted to $28,126.93. There was set aside a reserve for contingencies of $41,043.76. The remaining sum of $122,342.19 was distributed to the 8,979 laborers on the farm. The direct agricultural costs named above included wages of $602,777.51, which shows that the laborers participated in the net profits on the basis of $.203 per dollar of wage

By the end of the fiscal year 1945-46 the Land Authority had acquired 62,831.89

[6] The period may be extended on application by the Authority to the court.

[7] The other two methods are to divide the land into parcels from 5 to 25 acres for sale or lease to individuals, which parcels constitute maximum individual holdings, and to divide the land less suitable for agriculture into small parcels and cede these parcels gratuitously to agricultural laborers with the understanding that such laborer will erect his home thereon within a specified time.

[8] Exhibit 4, *Report* of the Land Authority to the Legislative Assembly of Puerto Rico for the fiscal year 1945-46.

[9] For administrative and accounting purposes, the breakdown seems to be Land Authority—Agricultural project—proportional-profit farm. These figures are from the report of a project which includes a convenient number of proportional-profit farms.

[10] A rent is payable to the Land Authority In an amount sufficient to amortize the cost of the land to the Authority within 40 years.

cuerdas[11] of land, which represents 2.9 of the total area of Puerto Rico. As of this date, three agricultural projects were in operation comprising a total of eighteen proportional-profit farms. The three projects harvested a total of 11,813.72 cuerdas of land in 1946, the remainder of the land apparently being devoted to other programs under the direction of the Land Authority.[12]

The entire land reform movement was attacked in the courts as an illegal use of the power of eminent domain. Condemnation proceedings were brought by the People of Puerto Rico, in behalf of the Land Authority, against Eastern Sugar Associates. In accordance with the procedure provided in the land law, the petition set forth the proposed distribution of the land condemned into individual holdings, proportional-profit farms and homes for agricultural workers. The sugar corporation contested the action on the ground that it appeared from the pleadings that its land was not to be taken for a public use, rather that it was to be sold or leased to others. The court held[13] that use by the entire community or even a large portion of it was not the test; that it was rather a question of whether the taking was in the best interests of the people and their prosperity. The existing social and economic conditions in Puerto Rico, the court felt, attested to the reasonableness of the Insular Legislature's belief in the existence of the evils it attempted to cure. Further, the means adopted were reasonably calculated to deal with the problems. This decision seems to bear out an above statement to the effect that the 500-acre limitation was a convenient political wedge. In those states and territories under the authority of the Constitution of the United States the courts in considering a reform of this nature will look to the exigencies of the situation confronting the legislature and certainly great weight will be given to the latter's determination that such action is necessary.[14] This test is in no way dependent on Congressional limitiations on land-holdings by corporations or individuals. It is also clear from the decisions that the reform need not be limited to the breaking up of corporate holdings, although the present legislation in Puerto Rico is directed toward that end. The same test would be applicable in the case of large individual holdings.

The land problem in Puerto Rico consisted of an accumulation of large landholdings in the hands of outside interests without giving those who tilled the land a fair share of the proceeds. The people of Puerto Rico are attempting to solve this problem without endangering the efficiency of production which naturally accompanies larger landholdings. The means which the people of Puerto Rico have adopted to solve this problem is to have the ownership and control of the best agricultural land vested in a governmental agency. Neither the administrator nor the laborer fit any of our Anglo-American legal concepts of lessee, tenant, purchaser or owner in fee. The system is unique in the Western Hemisphere.

GLENN COATES

Law School,
University of Wisconsin

[11] A cuerda is approximately .9 of 1 acre.

[12] Seet footnote No. 7.

[13] *People of Puerto Rico* v. *Eastern Sugar Associates*, 156 F 2nd, 316, 1946; certiorari to Supreme Court of the U. S. denied 329 U. S. 772, 1946.

[14] Cf., *Fall Brook Irrigation District* v. *Bradley*, 164 U. S. 112, (1896), *Clark* v. *Nash*, 198 U. S. 361, (1905), *McClean* v. *Arkansas*, 211 U. S. 539, (1909).

Book Reviews

Real Estate Analysis. By William H. Husband and Frank Ray Anderson. Chicago: Richard D. Irwin, Inc., 1948. p. xiv, 576. $5.00.

This textbook treats real estate in relation to law, finance, the market, the economy and the public. Value, sales, appraisals and percentage leases are clearly explained. Inequitable property taxes are criticized; capitalization is omitted. The real estate lobby is ignored and the frequent little preachments against government "encroachment" become tiresome. The book is weak on (1) real estate finance, (2) the building industry, and (3) theoretical analysis.

Real Estate Finance. Although "package" mortgages, construction loans, the scarcity of equity capital and the hazards in lengthening maturities are illuminated, the mortgage market—including sources of funds—is inadequately analyzed. Sound financing should facilitate good housing; but their sole criterion is ultimate self-sufficiency (p. 363). Elasticity of demand for housing and of the derived demand for loans is omitted; the adequacy of mortgage rates (p. 359) and the counter-cyclical influence of flexible financing (pp. 231-2, 362, 378) are underdeveloped. The authors, criticizing FHA more than the FHLB System, might have explored the possible integration of our bifurcated mortgage structure. Are savings and loan associations really the best potential source of funds (p. 386) and the Federal Home Loan Banks "the only existing permanent and functional source of secondary credit" (p. 422)? Actually mortgage insurance—which, they fear, may become a "subsidy" (p. 409, etc.)—improves marketability and promotes secondary financing by tapping the greater resources of commercial banks and insurance companies.

The Building Industry. Housing is confused, say the writers, "by a mixture of sociological and economic thought," and the desire to improve living standards" exerts a pressure . . . not commonly found in" other industries (p. 78). (I think most industries serve the public better; consider also the transcendent importance of housing.) To them, poor housing indicates inadequate family income, not construction inefficiency (pp. 79, 512); and high costs are today "caused almost entirely by a difference in the price level and not by deficient building methods" (p. 89). This excuses industrial inefficiency, confuses price and production problems with unequal income distribution, and evades the central issue. A single industry cannot raise all incomes, but it can feasibly reduce costs.

Theoretical Analysis. Problems on the frontiers of real estate are ignored: e.g., monopolistic and imperfect competition in real estate and mortgage markets; mortgage-lending policies in relation to banking theory. Price fluctuations and real estate cycles (ch. XIV) are superficially treated, without charts or graphs. The authors frequently imply that (gross) rent control has restrained construction, yet admit that net income increased because of reduced vacancies and deferred maintenance (pp. 251n, 326). Their conception of supply and demand is unsophisticated: rising prices "add to the supply while curtailing the effective demand" (p 538). Always? They fear that the momentum of accelerated construction "will carry new building beyond the point of justified long-term balance" (p. 552). To balance supply with market demand rather than with need may satisfy real estate interests, but not the public.

This is not a distinguished textbook, but its interesting case studies and recent statistics will be useful for reference.

PAUL M. GREGORY

University of North Carolina

Family Farm Policy. Edited by Joseph Ackerman and Marshall Harris. Chicago: University of Chicago Press, 1947, pp. xxii, 518. $4.00.

Family Farm Policy consists of the proceedings of an international land tenure conference held at the University of Chicago during the spring of 1946. The title captures public interest in a popular subject but it is somewhat of a misnomer because the contents of the book are more concerned with tenure arrangements under which farm lands are owned and operated. This hiatus between family farm and farm tenure as expressed by book title and content runs through several chapters. Such heterogony has caused much confusion in tenure phases of land policies throughout our national history. From studying our land policies, family farm appears to derive its significance primarily as an operating unit or "firm" concept. Thus, family farm is not dependent upon property arrangements under which land is owned or operated: it could be operated by a tenant, full owner or part owner. On the other hand, the "freehold" idea is developed and championed by Jefferson and Benton, among others, is basically a property concept. If the two concepts—firms and freeholds—are confused, public policies may find themselves in the dilemma of achieving ownership by the operator at the expense of efficiency of operation and economic well-being of the farm family.

The book contains two major parts. One part, 13 chapters, describes tenure systems and reforms in the United States, the British Commonwealth, Northern Europe, Latin America and Central Europe. The other part, 5 chapters, consists of committee reports analyzing various tenure problems and recommendations for improvement. The remaining two chapters involve a summary of the conference and a look to the future.

The idea of bringing people together from various cultural and political environments was well-conceived. This cross-fertilization of ideas and developments cannot help but stir people out of the ruts and lethargy of the accustomed way of doing things in the home country. We cannot help but regret, however, that more countries were not represented at the conference but conditions at the close of the war were not conducive to wide attendance. Unfortunately, countries which have experienced some of the more significant tenure reforms were absent. These include such countries as Mexico, Russia, Ireland, Denmark, Bulgaria and Japan and numerous other areas discussed by Liversage in his little book *Land Tenure in the Colonies.* Furthermore, India and China where most of the "two-thirds of the people of the world get their living by working directly on the land" reside, were not represented. The current F.A.O. land tenure study under the direction of Professor K. H. Parsons should fill some of these gaps in the world tenure situation. [Cf., p. 293, this journal. *Ed.*]

Five committee reports are, from an analytical viewpoint, the heart of the report. Of course, these reports reflect the usual effects of committee work where compromise takes the keen edge off individually creative and unusual ideas. Nevertheless, the reports do reflect the thinking of some of our leading social scientists on important aspects of tenure problems and policies. These reports deserve careful reading by all students of land problems.

The Schultz committee did an exceptionally fine job in trying to think through a very difficult problem concerning the definition and role of family farms in our land tenure system. Despite the forward thinking of this committee, "family farm" remains one of the most ambiguous terms in the social scientist's vocabulary. Several members of the committee disagreed with ideas presented in the main part of the committee report. Furthermore, other sections of the report did not use this nor any other consistant definition of the term. Maybe the term defies definition. Or perhaps family farm has become a "sacred cow" with which to disagree is heretical but which no one is able to describe in terms understandable and acceptable to others.

If the family farm is a means to an end as the report states and with which I agree, then more consideration should be given to an analysis of the ends it is intended to achieve. Also, more attention should be devoted to finding and developing alternative means which might serve the desired ends as well or better. Admittedly, the conference included as family farms only one-half of the farms counted by the U. S. Census. If the family farm accounts only for one-half of the total

census farms, then what are the alternative means for explaining the other fifty per cent? Of course, anyone who has worked with census data knows their limitations in this respect. The concept of "economic classes" begun in 1945 and planned for more complete use with the 1950 census should afford a much more workable basis for farm classification than we have had in the past.

In reading the book, one should not omit the "Foreword" by Howard Tolley which ties tenure arrangements into the freedom from want goal of the United Nations. Neither should the reader overlook the stimulating final chapter of "Looking To The Future" by H. C. Taylor which stresses the interrelationships between research, education and legislation.

Messrs. Ackerman and Harris, two of the nation's foremost students of farm tenure, not only did an admirable editorial job; they also prepared an excellent interpretative summary of the conference for the busy reader who has not the time to wade through the entire volume. Harris and Ackerman also went beyond the usual editor's role in helping to plan, organize, and see through the conference to a successful conclusion.

The volume is a distinct contribution to the literature on land tenure. It is recommended reading for all citizens who want to become better informed on farm tenure aspects of land policies. It is must reading for all students in land policies and provides a needed reference for college students in agricultural policy courses.

JOHN F. TIMMONS

Iowa State College

Books Received

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Correction: *A Critical Review of Research in Land Economics.* Leonard A. Salter, Jr., was listed at $5.00 in the May issue of this journal. The publisher, University of Minnesota Press, has notified us that the correct cost price is $4.00.